BRITISH SOCIETY

FOR THE

STUDY OF ORTHODONTICS

1959

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INHERENT ERRORS IN CEPHALOMETRIC FILMS AND THEIR REDUCTION

By **Professor G. E. M. HALLETT**

The development of cephalometric analysis by means of X rays in the late twenties suddenly gave a new tool for the examination of the cranial skeleton. No longer was it necessary to compare an assortment of dried and anonymous bones whose different ages could only be determined within broad limits (the cause of death being quite unknown), in order to formulate a pattern of cranial growth. When measuring the same individual over a growth period, considerable lack of precision had to be accepted due to variations of individual assessment, the adjustment of instruments, and also to variations in mobility of the soft tissues overlying bone at different times of life. Photography could help with profiles and over-all outline, but here, too, inaccuracies arose all too easily, partly through lens aberration, and the fact that a single lens can only "see" tangentially so that partieularly in stout people a quite false outline results. These deficieneies ean, in part, be remedied by using high quality lenses and by photographing the patient from a considerable distance.

At first, the head-plate seemed to get over these troubles. The X rays penetrated bone and gave us suture points and bone borders, and, because they penetrated bone, the full limits were clearly seen. The old points of anthropology and biometry were quickly identified, or remodified together with a host of eponymous planes and angles, and other points. A great number of analyses depending upon geometrieal constructions were invented to provide diagnoses from the relations of the bony structures to each other, and malocclusion became a phenomena almost entirely of skeletal structure and origin. To help to make these head-plates as accurate a record as possible Broadbent constructed his well-known cephalometer, whieh eombines the accuracies of an expensive lathe and a high-class optical instrument. This instrument allowed fixation of the head by means of ear-rods, which were both alined on the central ray of the tube which was 60 in. away from the mid-sagittal plane of the patient. By exposing sueeessive head-plates over a period of several years the films could be eventually superimposed and thus growth and tooth movements (artifieial and natural) studied. Also, the soft tissues eould be examined by suitable screening or other devices. However, to begin with, the soft tissues were rather ignored. Nevertheless, for the first time, a study could be made of the same individual from birth to maturity, and this was a most exciting advance. Since these early beginnings a vast amount of literature has been produced about roentgenographic cephalometry, as it came to be called, and those who have perused the weighty synoptic review of Krogman and Sassouni (1957) will realize the way in which the method has dominated orthodontic thinking and the valuable information that it has given us. But it has not all been advance. Many workers have become so engrossed with this tool that their minds and critical faculties tended to become first hypnotized and then paralysed by it. Diagnosis became a matter of planes and angles, the latter being sub-divided into seconds of arc and lengths measured by millimetres and parts of a millimetre. Arbitary points of superimposition were defined from which it was inferred that all growth takes place centrifugally, a very popular area being somewhere in the body of the sphenoid. Curiously, when the biometrist studies serial growth of the body as a whole he measures standing hcight from the floor; he does not usually put a pin through the umbilicus, though pcrhaps he should! However if we

Presidential Address given at the meeting held on Jan. 12, 1959.

are going to use the method at all we must have a "superimposition" point somewhere. The important thing is not to make it too sacrosanct. The other thing to remember is that what we are studying is a shadow picture or, to use Grcek roots to say the samc thing, a "skiagram". What we sec are projections of our hard and soft tissues, and, because the latter have depth and breadth and because they must nccessarily be a distance from the sensitizcd film varying from $1\frac{1}{2}$–6 in., cvery recorded shadow registered must be falsified to a greater or lesscr degree. It is very like the camera problem previously mentioned. Our image is both enlarged and distorted. There are other troubles inherent in the cephalometric head-plate which I can only touch on here and some of them are again those of the photographic method.

1. The patient may move, producing a fuzzy image. The cure is stabilization of the patient (the cephalostat), arrest of breathing during exposure, and as short an exposure as possible. The latter implies a high-power machine.

2. The ray source may move, again blurring the image. The cure is obviously a well-constructed and solid mounting for the tube.

3. Short exposures which, as so often in photography are obviously desirable, are essential for cephalometry by X ray and are also hclpcd by using fast films and intensifying screens. Fast films, however, tend to have coarse grain, and intensifying screens, by reacting to X rays and producing light, render the imagc less sharp because of halation.

4. Loss of definition is also caused by secondary radiation and this is reduced by using suitable hollow cones and cylinders to limit the ray bundle size leaving the tube and also by other dcvices at the film end such as the Schönander and Potter-Buckie screens. Thc Schönander screen, whilst improving the image, has the disadvantage that the grid shadow can be seen on the film. The Potter-Buckie gets over this by using a grid which moves during exposure. The disadvantage of the Potter-Buckie grid is that it interposes a further 2 in. between the patient and the film, thus increasing the cnlargemcnt error.

5. Loss of definition is also brought about by the penumbra due to the size of anode bcing bombarded. This error is reduced by having (*a*) the tube as far away from the patient as possible, and (*b*) by using a high cnergizcd tube with a rotating anode so as to give a focal spot of 1–$1\frac{1}{2}$ mm. square. At 60 in. and more, the penumbral problem is virtually eliminated.

6. We are left with the errors of magnification and distortion. Again these are reduced by having the greatest practicable distance between the tube and the patient (Korkhaus has suggested 13 feet) and the shortest between the patient and the film. Both are minimized by having the patient's sagittal plane at right angles to the central ray. The other errors are reduced by the best combination of kVA, stability, screening, and the head fixation possiblc.

A patient being X-rayed for a head plate should be comfortable and his radiation dosage should be the minimum possible. In general, I personally like a high kVA machine (80), 100 ma. 92 in. target/film distance, fast film, and a Potter-Buckie grid which allows an exposure of from 0·6 to 1·2 sec. A comfortable cephalostat is a great advantage and is a good thing if arrangement is made for keeping the mid-sagittal plane a constant distance from film and anode.

These errors have, of course, been known ever since X rays were used, but not many determined efforts havc been made to reduce those of enlargement and distortion beyond stipulating a 60-in. distance or greater between cathode and film and very accurate positioning of the head in rclation to thc central ray.

Adams (1940) investigated the enlargements and variations of angles in head-plates by X-raying a scries of skulls bearing metallic implants. The precise relations of these implants were measured on the skull by means of a special Western Reserve cephalostat. He also constructed a special correctivc scale which would be mounted in the mid-sagittal plane and thus produce an image on

Fig. 1.—Showing natural skull mounted in relation to two film positions "X"=72 in. and "R"=74 in. Divergent black lines are taut threads stretched to a focal point actually at these distances so that the angles subtended are accurate. The displacement of the various points and their corresponding enlargement on the two film positions can plainly be seen by comparing with the parallels on the graph paper at T–T′ and V–V′. The three main planes for which correction was attempted are shown at A, B, and C. The range of magnification between points **1** and **2** is from 1·12 per cent to 9·6 per cent at X and from 4·2 per cent to 13·8 per cent at R.

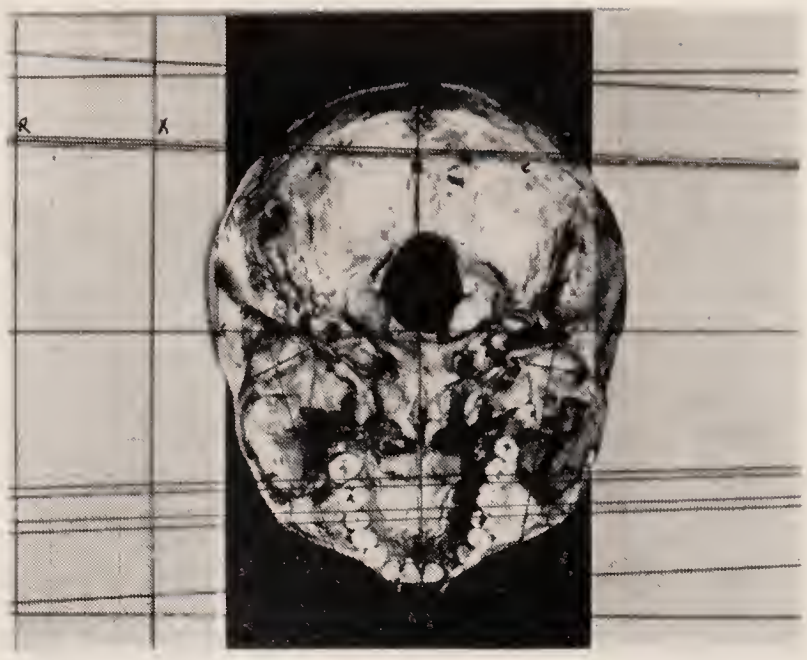

Fig. 2.—Shows the same skull in plan. Note the displacement of the right and left molar shadows and how their true mediodistal diameter will *not* be registered at all, only the greatest diameter from distolingual tangent to superimposition on premolar shadows. At A, B, and C, three hypothetical points at right angles to the sagittal plane and in the same line become three separate points on the film, either at X or R.

the film. Amongst his conclusions was the statement that corrective scales should always be used in cephalometric appraisals. Adams examined 50 skulls by this method, and tabulated his results.

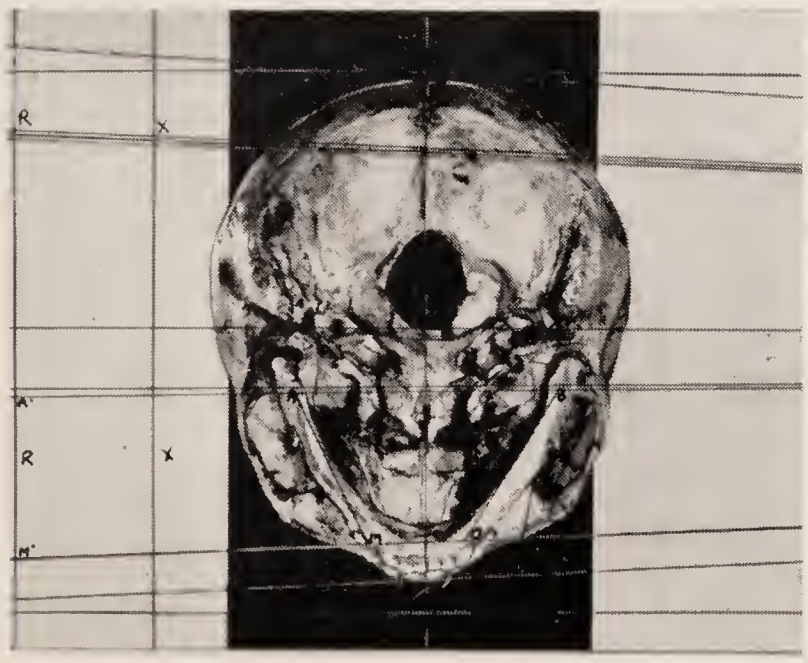

Fig. 3.—The mandible has been superimposed. Note how the obliquity of the mandible lengths A–M and B–O distorts the shadow at R and X reducing the magnification. In this case A′–M is equal to A–M whilst it is markedly less than B–O which is the side nearest to the tube.

Thurow (1951), in an informative paper, discussed cephalometrics in private practice and many of the sources of error. He suggested using a specially adapted vernier on a slide rule to make the required corrections for distortion and magnification where special serial studies were being made to high degrees of accuracy. For ordinary assessments he suggested correction to be unnecessary.

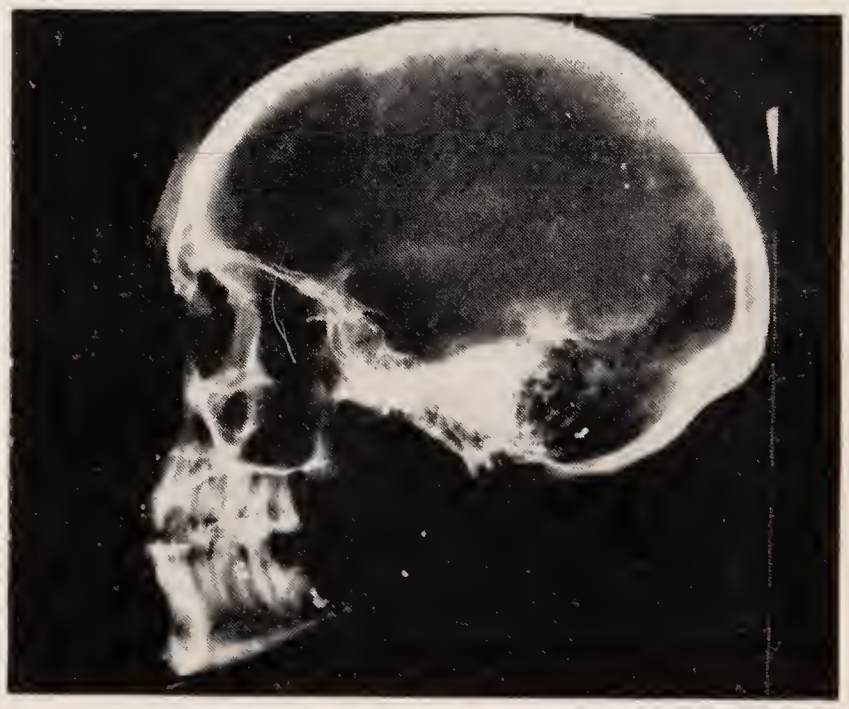

Fig. 4.—Skull with main points marked by small amalgam inserts. Measurements made on this specimen were unsatisfactory for the reasons given in the text.

Franklin (1952), in an excellent contribution, discussed many of these factors again

and in particular illustrated the geometry of enlargement and penumbral shadows. Beyond the usual recommendations of a long tube/patient distance and a short patient/film distance he made no other comments on solving the problems of distortion and enlargement.

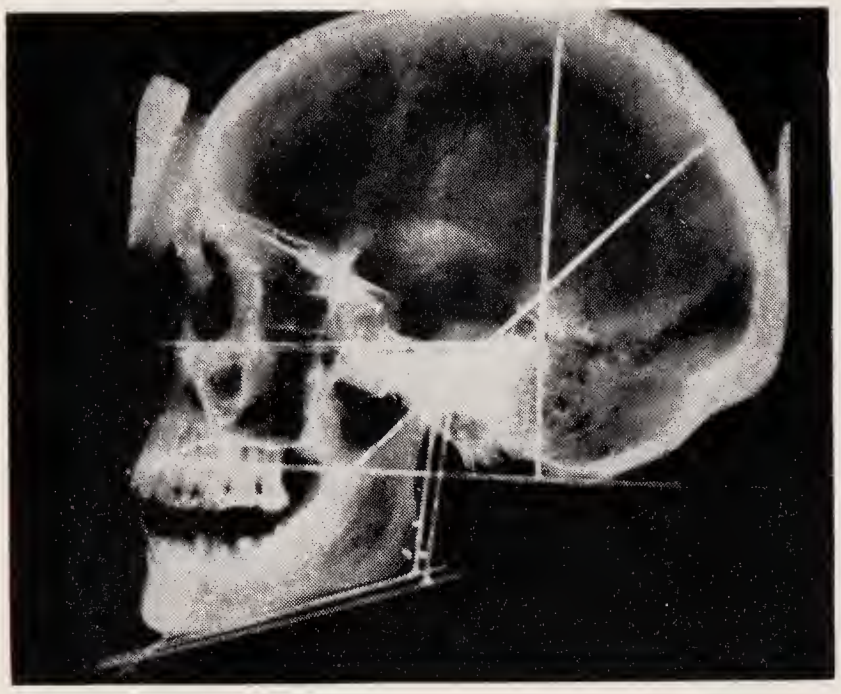

Fig. 5.—Skull with main planes indicated by calibrated rods. This gave more precise results regarding angles and linear enlargements, but the sagittal plane could not be accurately determined without sectioning the whole skull.

Kean (1958) examined a series of cases, Class II, division 2 malocclusion, for "aspects of facial depth". In order to make accurate measurements on his head-plate he felt that correction would have to be applied to his headplate films, and he constructed an ingenious millimetric scale which was radio-opaque and, placing this in the mid-sagittal position, he X-rayed this and used the superimposed scale to read off his dimensions in true millimetres.

To my mind this was the first practical attempt to apply corrections to the head-plate for enlargement error. Elaborate tables involve very tedious correlation and plotting which means that they can only be used for isolated measurements. The Wylie compensator has certain advantages but was designed

Table I.—Some Observations on Cephalometric Films exposed at 72-in. Anode—Buckie Distance on (1) Bony Skull (*see Fig.* 5); (2) Plastic Skull (*see Fig.* 6)

	Bony Skull			Plastic Skull		
	Actual	Film	Per cent mag.	Actual	Film	Per cent mag.
Skull height	135 mm.	146 mm.	8·14	112·0 mm.	120·0 mm.	7·1
Basic length	176 mm.	190 mm.	11·14	130 mm.	142·5 mm.	10·4
Right Frankfurt (horizontal)	90 mm.	91 mm.	1·1			
Left Frankfurt (horizontal)	100 mm.	104 mm.	2·5			
S.N. Bolton pt. angle				13°	13°	Nil
Mandible						
Right						
Ramus (horizontal)	112 mm.	112 mm.	0	78 mm.	85 mm.	8·97
Ramus (vertical)	55 mm.	57 mm.	3·63	54 mm.	56 mm.	3·7
Gonial angle	111·5°	113·5°	1·8	110°	111·5°	0·8
Left						
Ramus (horizontal)	112 mm.	112 mm.	0	78 mm.	85 mm.	8·97
Ramus (vertical)	55 mm.	59 mm.	7·26	58 mm.	65·5 mm.	7·7
Gonial angle	112·0°	114·0°	1·8	110°	110·5°	0·454

mainly for A.P. films. For some years I have been particularly interested in projection error (*Figs.* 1–3) and having over the last twelve years accumulated a considerable number of serial lateral skull films, have been interested in examining them for growth and for changes following orthodontic treatment.

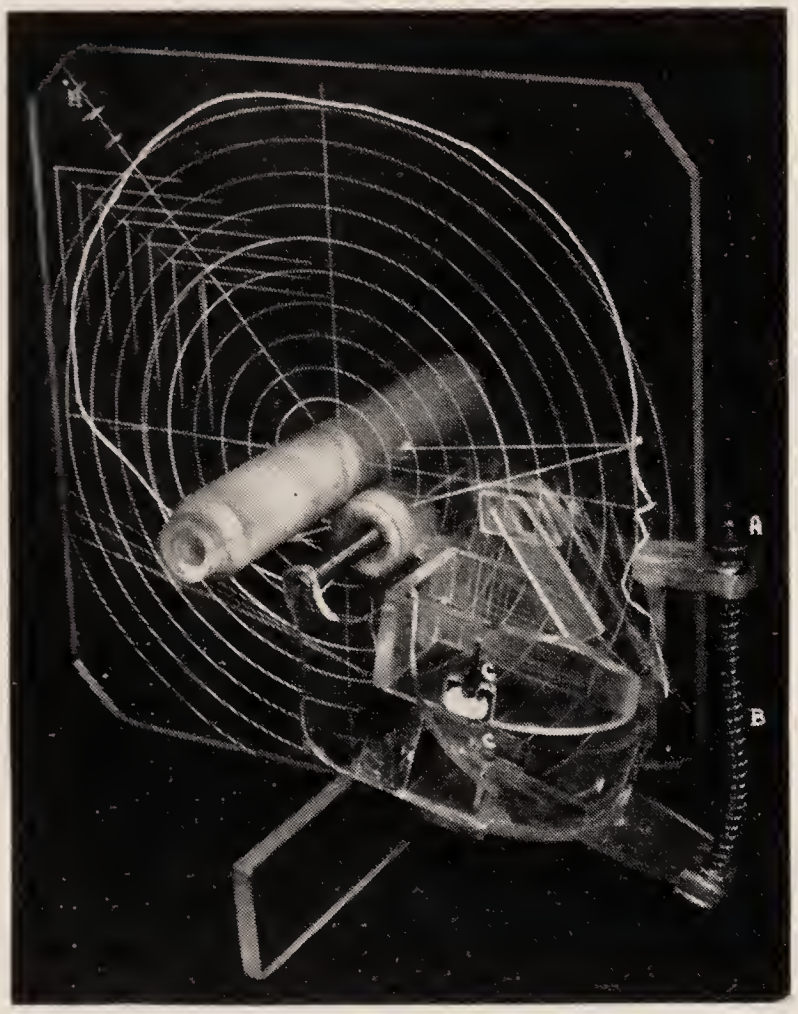

Fig. 6.—Perspex skull. The sagittal plane could be isolated for copying, and could be scribed with radio-opaque points and lines. The mandible and other points away from the median plane could be exactly symmetrical and variable within precisely determined limits.

I was not able, however, to embark upon the vast quantity of correction that tables and individual plotting would require and therefore made some investigations of my own. I started, like Adams, with a natural skull, using metallic implants (*Fig.* 4). This method, however, was rejected. The implants had to be too thick and clumsy and changes in orientation of a cylinder, however small, altered its image and dimensions, thus making for lack of accuracy in plotting points. In order to improve on this, a natural skull was taken and the main planes were put in in the form of fine metal rods (*Fig.* 5) (fine orthodontic tubing). Separate rods were used for the right and left Frankfurt horizontals for the right and left mandibular planes, posterior planes, for length of cranial base, height of skull (basion to bregma), etc. These wires were divided into centimetres, some by having fine cross cuts at centimetre intervals, and others having very fine stainless steel wire welded on to them. Measurements made from this skull are shown in the three columns of the left side of *Table I*. The following observations were made from the films of this skull:

Sagittal dimensions crossing central X-ray axis increase from 7–8·5 per cent.

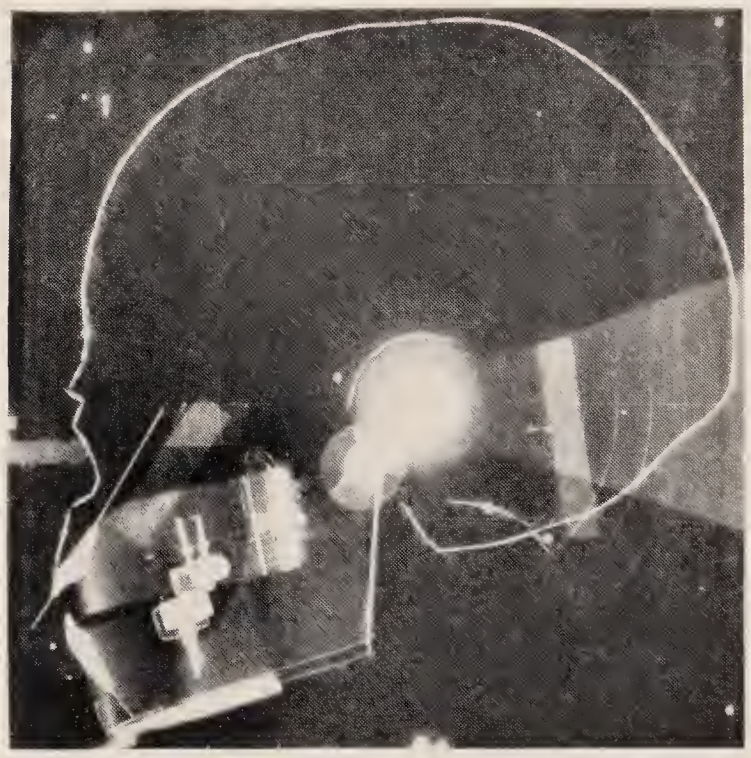

Fig. 7.—Head film made from perspex skull mounted in the cephalometer and radiographed.

Sagittal dimensions away from central X-ray axis increase from 10–11 per cent.

Sagittal angles alter too little to make any significant difference. Lateral angles, e.g., gonial, away from central axis open 1–2° (agree with Adams). This may open mandibular/Frankfurt or mandibular/palatal plane angles. Divergence of lines from central point tends to cancel out enlargement by distortion (*see Fig.* 3). This is a very variable factor differing between individuals and depends on the degree of obliquity of horizontal rami from the medium plane. After this, it was decided to construct a synthetic and symmetrical skull from perspex (*Fig.* 6). This could have lines, angles, and concentric circles marked upon a sagittal plane (unattainable with the natural skull). The lines were scribed and then filled in with white lead

paint (heavy-bodied) to make them radio-opaque. Certain parts were made movable using screws so that the movements could be precisely determined. For example, rotation of the "molars" C through $2\frac{1}{2}$ turns was equal to an "eruption" of 1 mm. The skull was mounted in the cephalostat and exposed in the normal way. The resultant film could then be examined without having a great deal of obscuring detail. The procedure was as follows: A head-plate film was numbered and the film exposed (*Fig.* 7). Various adjustments were then made either by moving the molars through a definite distance upwards or downward or by dropping the mandible a precise distance by turning the nut A on the threaded and spring-loaded rod B through a definite number of revolutions. Further films were numbered and compared. These films could be superimposed exactly upon each other, and then by dismantling the skull and laying the sagittal portion on a film and exposing again a "contact" print could be made. The enlargement errors could then be precisely examined between actual size and film size and also the error between the actual movements and the recorded movements. *Fig.* 8 shows two superimposed tracings. The inner one is made directly from the sagittal plane of the perspex skull, the outer one is the tracing of the head-plate made as shown in *Fig.* 7. From this figure we can see plainly: (*a*) the overall degree of enlargement; (*b*) the successive and increased displacement of points from the centre to the periphery (line P–O).

The right angles scribed in the occipital quadrant show no detectable change of angle between actual and film registration (they are of course displaced centrifugally). Another experiment was to expose two films without altering the "skull" at all. The first was made with the central ray alined on porion (*Fig.* 7), the second with the central ray shifted to the canine region. Studying the results of measurements made on successive films from the plastic skull leads to the following conclusions: Skull measurements of 1–$1\frac{1}{2}$ mm. are not clearly differentiable on the film to decimals of a millimetre. This means that, particularly in the molar region, it is invalid to try and work to less than a millimetre of accuracy.

Change of central ray by $2\frac{1}{2}$ in. produces profound film change registration of central points, and points up to molar distances from porion and also in the relative film registrations of near symmetrical points (R. and L. molars) by parallax. (Note *Figs.* 7 and 9.)

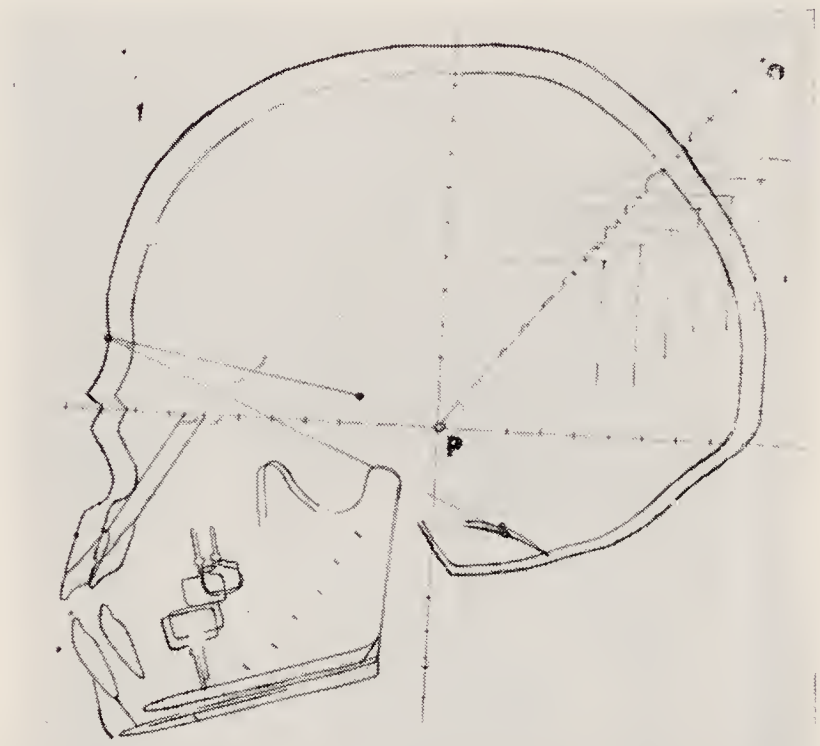

Fig. 8.—Tracings made from former film (outer line) and actual median perspex plane (inner line).

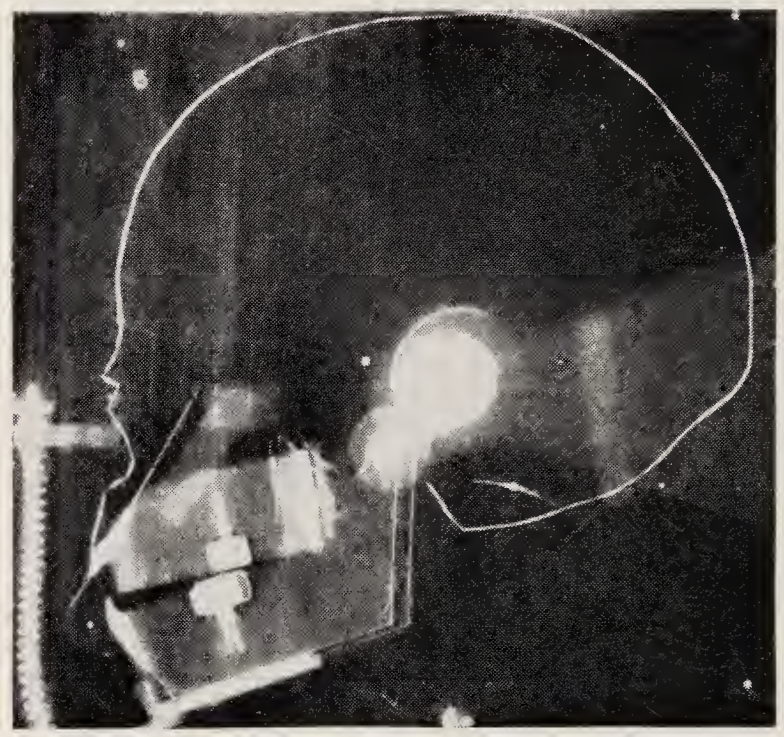

Fig. 9.—Head film made after tube had been moved horizontally $2\frac{1}{2}$ in. towards the "canine" region. Compare with *Fig.* 7 and note changes in "molar" shadows and widening between posterior planes of mandible.

Change of central ray by this amount produces remarkably little change in the recorded profiles, i.e., between the profiles of *Figs.* 7 and 9.

Magnification follows clearly-defined mathematical laws, and the extent is given by this formula:—

$$\text{mag.} = \frac{D}{D-d} - 1 \times 100$$

where D = distance from anode to film
d = distance from object to film.

It follows that there will be considerable differences in enlargement between the right side of the skull and the left. For example, if the film is placed at 72 in., i.e., as close to the head as possible without interposing screens, the enlargement will be as follows:—

Film side molar	*Median points*	*Tube side molar*
3·5 per cent	5·1 per cent	6·66 per cent

With the Potter-Buckie interposed, percentage magnification is correspondingly increased as follows:—

Film side molar	*Median points*	*Tube side molar*
6·47 per cent	8·0 per cent	9·63 per cent

A considerable number of other measurements were made, which it is not proposed to discuss here, except to say that it became apparent that the interpretation of fixed lines and points under almost ideal experimental conditions still resulted in inaccuracies, even when plotted with the utmost care using high-grade instruments. It was concluded that when working upon a living person where conditions are complicated by (*a*) growth, (*b*) slight variations in head position due to separate fixations in head positions at varying time intervals, and (*c*) slight variation in porion alinement due to soft tissue mobility around ear-plugs, a considerable amount of inaccuracy must be accepted and only very definite and marked variations from previous records accepted as significant.

The next stage was to find whether an instrument could be constructed to "recover" from the film a plotting of the essential features in such a way that would be obtained if all the X rays were parallel and not divergent, i.e., to cancel out, or markedly reduce, the magnification factor from an average of 6–10 per cent to about 1 per cent. It was felt that if this could be done easily and automatically, the results of tracings would have greater value where accurate deductions had to be made. A pantograph seemed to be the obvious instrument, but no suitable one was available commercially and a series of pantographs were constructed with successively different

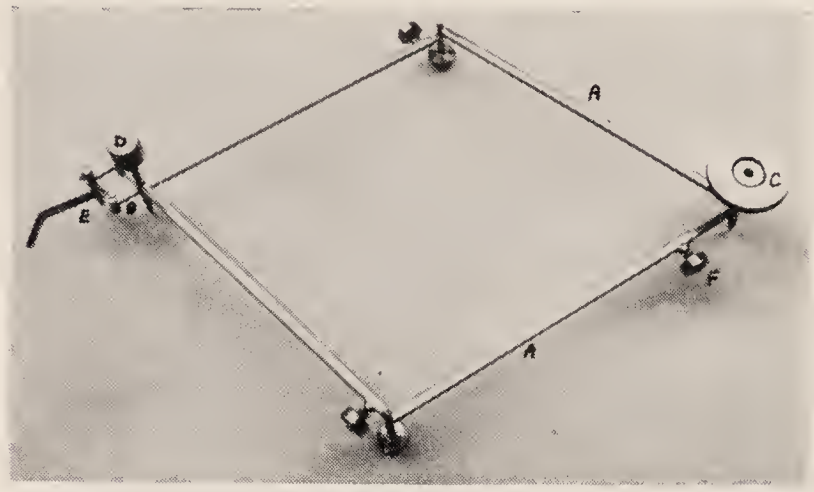

Fig. 10.—Pantograph for correcting enlargement error.

modifications until one was found to give the required results. This not only had to satisfy the theoretical mathematics of the problem, but also had experimentally actually to "recover" from a film of the plastic skull, exposed at 74 in. anode film distance, the exact sagittal points scribed upon the central perspex plane. It was found that the pantograph illustrated in *Fig.* 10 would do this. The next stage was to be able to correct for magnification in two other main planes, i.e., right and left molars (A and C, *Fig.* 1). At first it was thought that three separate pantographs would be necessary, but it was found that an adjustable one could be constructed to satisfy the requirements.

The main framework of the instrument is constructed from square German silver tubing, as used for maxillo-facial work, with round tubing for the pivots and hinges, the whole assembly being hard soldered. By using square rods to fit the tubing for the major sides an extensible large square results, extension being controlled by circular screw stops on each side. The pin on the major square is sharpened so as to pierce through porion on the film and is weighted to hold it easily in place (*Fig.* 10, C). A 6H "Eagle" lead, suitably sharpened, fits into the tubing joining the

minor and major square, and thus forms a pivot between them. The lead carries a brass button (D) which can be pressed on lightly with the finger during use, thus compensating for wear. The tracing needle (E) on the minor

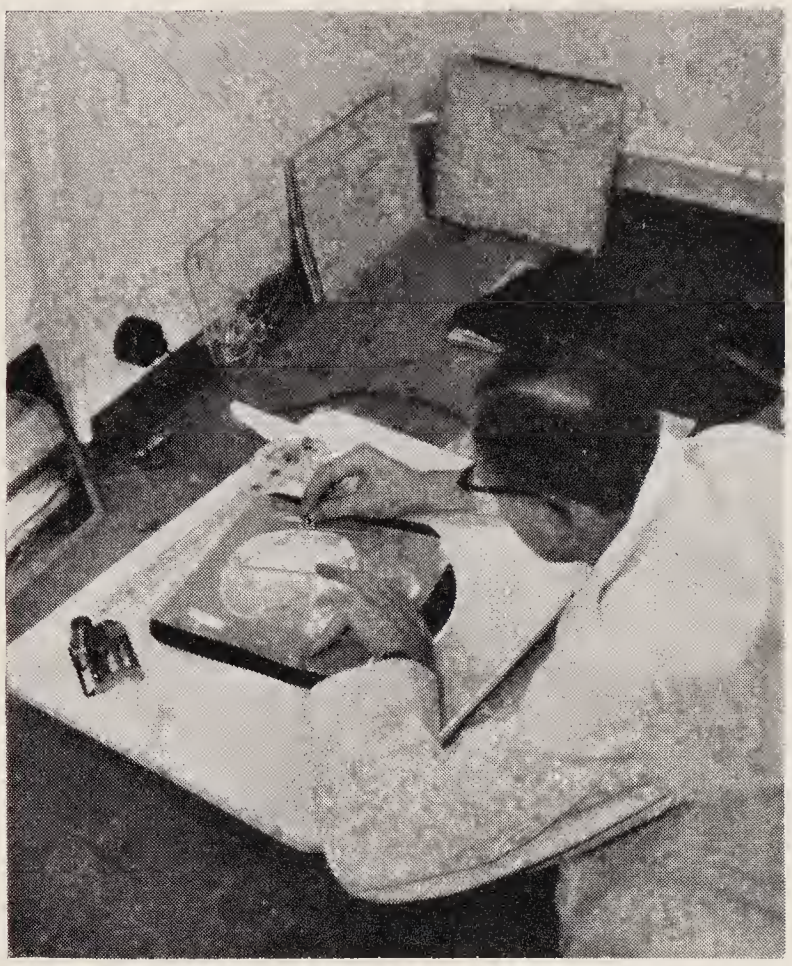

Fig. 11.—The pantograph in use on the rotating viewer. (The instrument shown is one of the earlier models made of round tubing.)

square (B) (0·36 in. side) is made to follow the outline on the transilluminated film, and the pencil then traces the true outline which is variably reduced according to the distance from the centre. The larger the major square the less the amount of correction. Three marks are made on the square rod, thus giving three separate corrections:—

1. The largest square is used for the film side of mandible, and for all cheek teeth (5·5 in. side).
2. The intermediate square is used for all sagittal points (4·75 in. side).
3. The fully closed square for mandible and cheek teeth (posterior to canine) on the tube side (4 in. side, A).

In order to use this instrument easily and efficiently a special viewer was constructed (*Fig.* 11). This employed a 12 in. circular fluorescent light behind a circular plate of glass mounted horizontally. The circular plate revolves on circumferential rollers and is flush with the surface of the tracing table surrounding it.

A small central hole is drilled through the glass plate and three other small holes at about 3–4 in. from it. A head film with an overlying sheet of tracing paper is then pinned to this plate by piercing ordinary pins through tracing paper, film, and glass. The central pin is then withdrawn, the weighted pin of the pantograph inserted in its place, and the

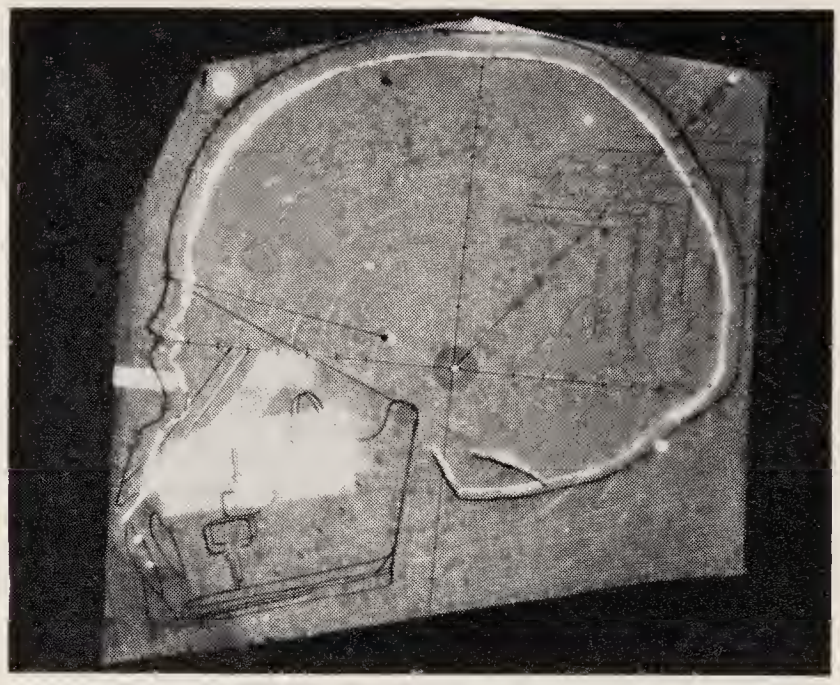

Fig. 12.—Superimposition of: (1) Tracing of head-plate 1 (solid outer line); (2) Actual perspex median plane with scribed lines (white); (3) Tracing by pantograph from outer line (faint black line superimposed on white line).

tracing now made. The head-plate and its supporting circular glass plate are rotated as convenient for right- or left-hand tracing. By suitable masking the soft tissues can be easily distinguished and it is a help to mark these on the actual film with an HB lead before reducing with the pantograph.

The first requirement of the pantograph was to take the actual sagittal perspex plane and a tracing of the head-plate film of the perspex skull so as to give *Fig.* 8, as previously explained. This was now centred through porion on a film of the first exposure (*Fig.* 7) and with superimposed tracing paper mounted on the rotary viewer as in *Fig.* 11. The profile and certain sagittal points were followed with the tracing needle of the pantograph and the resultant pencil trace should then follow the accurate inner correct line. This is not easy

to show in illustration, but *Fig.* 12 was the result after sueeessive empirieal modifieations of the pantograph. The peneil line overlying the aetual white lead seribed on the sagittal perspex ean just be distinguished.

Having attained this degree of aceuraey, aetual head-plates from live patients were traeed.

Fig. 13 shows the eorreeted serial traeings of a girl at 7 years 9 months and 13 years of age and *Fig.* 14 shows these traeings superimposed upon the original 13-year head film, showing the amount of eompensatory eorreetion.

Fig. 15 shows another girl between the ages of 6 years 3 months and 13 years 2 months: The solid lines are the eorreeted traeings and the outer dotted lines the aetual tracings from the head-plates. From these two eases showing different veetors of facial development, interesting measurements ean be made on the eorreeted traeings whieh will have greater validity than these made direetly on the original films.

It is not suggested that all head films should be eorreeted in this way, but where aeeurate measurements have to be made to find out what has been aeeomplished by orthodontie movement or by growth ehanges it must be important to have the minimum of magnifiea-tion and distortion error. It is felt that the instrument deseribed makes a eontribution towards this, and further work will be done to make it as aeeurate as possible. It should be borne in mind that rarely will the same instrument supply the eorreet eompensations for another eephalometrie set-up. Tests have to be made as deseribed, and the neeessary

Fig. 13.—Pantographieally reduced traeing of two serial head films for girl at ages 7 and 13 years.

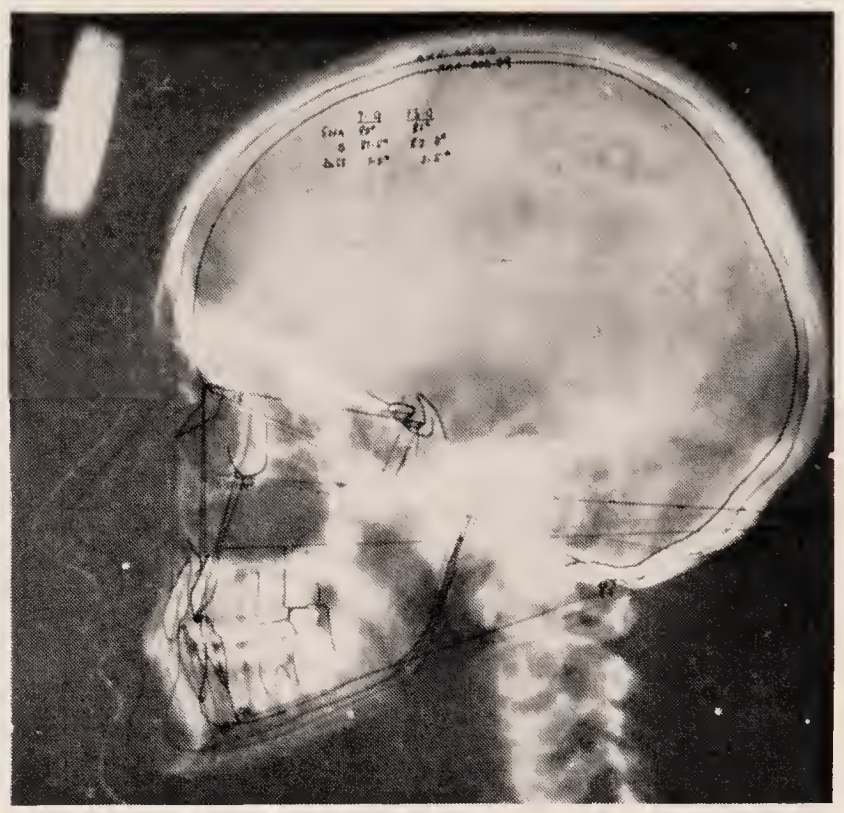

Fig. 14.—*Fig.* 13 superimposed upon aetual age 13 years head film.

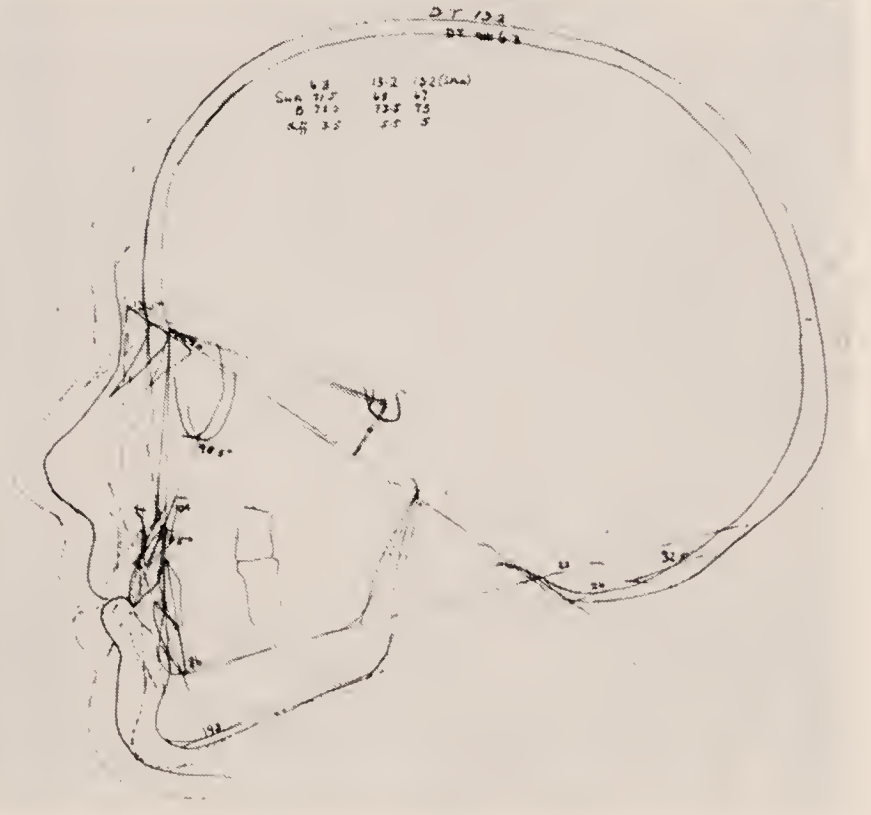

Fig. 15.—Traeings of serial head film for girl at ages 6 years 3 months and 13 years 2 months (solid lines—pantograph: broken lines—direet tracing from age 13 years 2 months head film).

adjustments made. However, by making the major arms adjustable, this should not be difficult in the first place.

Acknowledgements.—I am indebted to Mr. S. V. Haswell, Consultant Radiologist to the Newcastle Dental Hospital, for the facilities of his department, and also to Mr. Watson, Radiographer, for his help and co-operation. I would also like to acknowledge the kind help I have had from Commander (E) D. G. Thompson (Retd.), who made valuable observations of my original pantograph, suggested its present basic form, and helped me with some of the calculations.

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THE RELATIONSHIP BETWEEN SPEECH, TONGUE BEHAVIOUR, AND OCCLUSAL ABNORMALITIES

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This paper deals with one aspect of speech only, namely lisps or sigmatisms, and I shall endeavour to demonstrate that a relationship exists between this defect and certain of the problems which confront us as orthodontists.

It is generally accepted that dental irregularities are not a direct cause of a sigmatism, and that where the two are present in an individual case some common cause must be found. Froeschels (1937) found that sigmatism was due to tongue position and activity and not due to malocclusion. In 1935 Van Thal examined 180 children undergoing orthodontic treatment at the Royal Dental Hospital, and found that slight deviations in defective "s" and "z" sounds were not more common in these children than in controls with normal dentition. She excluded those cases attending the speech department. Van Thal (1954) asserts that a tongue-thrusting swallowing behaviour may be associated with an interdental sigmatism, but not necessarily so, and that other factors such as psychological ones must be considered.

I am not able in this paper to give a complete review of the literature, but I would just like to report Bernstein's (1954) conclusions on the relationship of speech defects and maloeclusion.

1. Children with speech defects do not have a greater amount of malocclusion than children without speech defects.

2. Speech defects are not related to malocclusion generally except in the classification of open bite.

3. In this classification there is a strong relation to lisping.

4. The severity of the lisp does not vary with the amount the bite is open or with the amount of overjet or overbite.

The most interesting and valuable work of Hopkin and McEwen, presented before this Society (1955, 1957), supports the view that, in general, speech defects are as likely to be found with normal occlusions as with malocclusions. No definite relationship between tongue behaviour and lisping was established by them and they felt that further investigations were needed.

I want first of all to report the results of an investigation of 200 children carried out at the Eastman Dental Hospital, London. It is important to realize that they were all attending the orthodontic department, and that they were, therefore, not representative of the child population as a whole. The clinical details of the malocclusion and tongue behaviour were taken from the original diagnosis made by either Professor C. F. Ballard or Mr. S. G. McCallin. The speech was evaluated quite separately by Miss E. K. Bond, Speech Therapist attached to the hospital. Before looking at the results I should state that an atypical swallow was defined as a tongue-thrusting swallow. The initial diagnoses were made at a time when there was no attempt made at differentiating between an "endogenous" tongue thrust—that is, one which is inborn and constituting a primary aetiological factor—and one which was secondary to other factors. I shall return to this question of swallowing behaviour later. Sigmatisms were divided into interdental sigmatisms, with the air escape anteriorly, and lateral sigmatisms, with a lateral air escape. The lateral sigmatism is much less common; the tongue is in contact anteriorly with the palate and incisors as in forming the letter "L". The sides of the tongue are down and not in contact with the teeth and palate, so that there is a lateral air escape.

Given at the meeting held on March 9, 1959.

Amongst other things, I wanted to find out whether the basic position of the tongue in relation to the incisors, as opposed to any abnormal behaviour pattern of an endogenous nature, had any aetiological significance in the production of a sigmatism. I also wanted to know whether an "ad-dental" sigmatism, where the tongue is pressed hard against the incisors, and produces a "th" sound, was necessarily accompanied by a tongue thrust, and whether this type of sigmatism had any different prognosis from an "air escape" interdental sigmatism. This question was not answered in the Eastman analysis, because this preliminary investigation did not recognize such a type. I felt that if we could differentiate between sigmatisms due to *position* of tongue, and those due to *function* of tongue, we might be in a stronger position to give a more accurate prognosis, both for the cure of the sigmatism and also for the correction of the malocclusion. Finally the importance or otherwise of lateral sigmatism seemed to merit investigation.

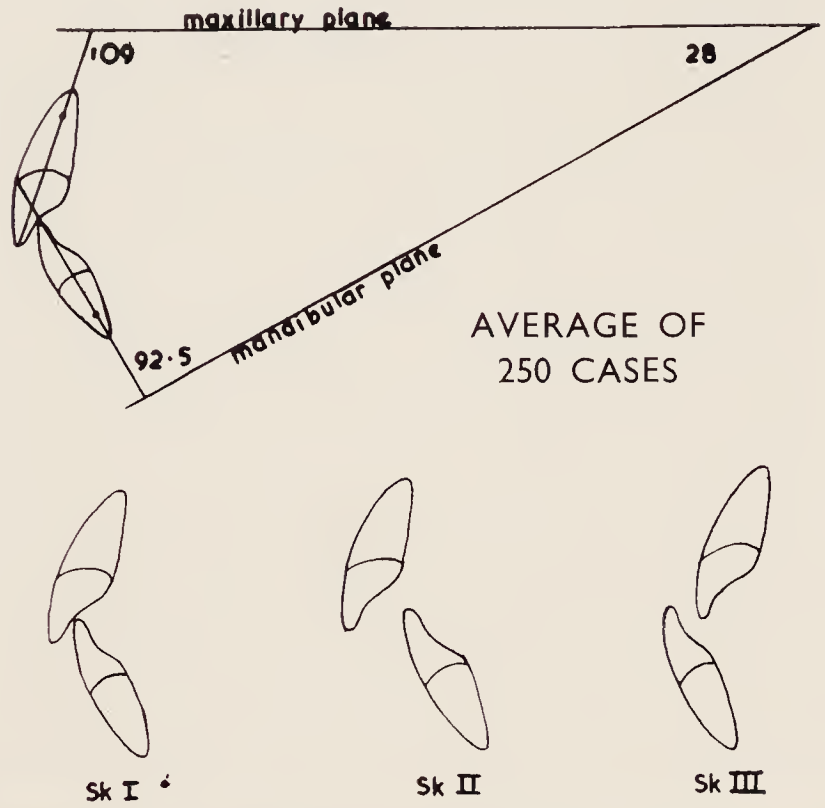

Fig. 1.—Assessment of skeletal pattern.

Tongue position was analysed in an antero-posterior direction by determining the dental base relationship. From the initial cephalometric X-rays of each case, conversion tracings were prepared according to the method advocated by Ballard (1951); from these, each of the 200 cases was typed as Skeletal I, II, or III, and it was felt that this would indicate the basic position of the tongue in relation to the maxillary arch (*Fig.* 1).

Analysis of tongue position in a vertical direction was carried out by two means: first, it was felt that the maxillary–mandibular plane angle itself might indicate to some extent the position of the tongue in relation to the maxillary incisors, and secondly the height of the tongue above the occlusal plane was noted. The X-rays were examined and the tongue position carefully assessed. Where the tongue did not completely fill the "inter-maxillary space" its height above the occlusal plane was noted. The resting position of the tongue above the occlusal plane is fairly constant, and *Fig.* 2 shows three X-rays taken of the same patient at different times.

Fig. 2.—Cephalometric X-rays showing low tongue position.

I have explained how swallowing and speech were assessed; the occlusion was a record of the incisor relationship.

RESULTS

1. Skeletal Analysis.—*Table I* shows the skeletal analysis according to the method elaborated above, together with the maxillary–mandibular plane angles.

There are 52 interdental and 10 lateral sigmatisms, and as I felt that different

mechanisms would be at work I have analysed them separately. The 52 interdental sigmatisms are split up as shown in *Table II*.

Table I.—Skeletal Analysis (200 Cases)

Sk. I: 67 or 33·5 per cent
Sk. II: 96 or 48 per cent } 66·5 per cent
Sk. III: 37 or 18·5 per cent }

Maxillary–Mandibular Plane Angle

Average for the whole group is 28·93°
Average for the separate skeletal groups:
Sk. I: 28·36°
Sk. II: 29·81°
Sk. III: 27·01°

Table II.—Interdental Sigmatisms (52 Cases)

Sk. I: 13 or 25 per cent (33·5 per cent)
Sk. II: 30 or 57·69 per cent (48 per cent)
Sk. III: 9 or 17·3 per cent (18·5 per cent)

Abnormal bases	Interdental sigmatisms on abnormal bases
66·5 per cent	75 per cent

Table III.—Tongue Position Analysis

Total Group of 200		106 *Low Tongues*
Interdental sigmatisms	26 per cent	29·2 per cent
Abnormal swallows	44·5 per cent	46·2 per cent
Maxillary–mandibular plane angle	28·93°	30·19°

There is, therefore, a greater number of interdental sigmatisms on an abnormal base than we would expect to find if they were distributed at random. The main increase is on the Class II dental base. This fits in with Leech's findings (1958). Anteroposterior position of the tongue therefore appears at this stage to be a factor in the actiology of the interdental sigmatism.

Now consider the maxillary–mandibular plane angle. The mean angle for the 52 interdental sigmatisms is 30·6°, and you may remember that the average for the whole group of 200 cases is 28·93°. In view of the fact that the 52 sigmatisms had different percentages of the various skeletal patterns from the total group of 200, and to obviate the possibility that a higher percentage of Skeletal II bases (with a higher average maxillary–mandibular plane angle) might in any case produce such a higher angle for the 52, a "corrected" maxillary–mandibular plane angle for 52 cases was worked out. This used the percentages of skeletal patterns of the sigmatism group with the individual average figures found from the total group. The "corrected" angle was found to be 28·95°, so that the figure of 30·6° is still high.

Lest it be felt that this figure was not significantly higher, and to help eliminate the possibility that a very few high angles had unduly coloured the sigmatism group, a further small analysis was made. If the 52 had a generally high maxillary–mandibular plane angle, there should be a greater number of sigmatisms in the high maxillary–mandibular plane angle cases than there were in the low. This proved to be the case.

Of the cases with maxillary–mandibular plane angles of 29° or over, 32·9 per cent were interdental sigmatisms; 22·1 per cent of the cases only were sigmatisms where the angle was below 29°.

I use the figure 29° because this was approximately the average for the whole group of 200.

There is, therefore, a correlation between the maxillary–mandibular plane angle and an interdental sigmatism.

2. Relation of Tongue to Occlusal Plane.—There were 106 cases where the tongue did not completely fill the intermaxillary space. This was over half, and the average maxillary–mandibular plane angle was 30·19°. This was an expected result; we like to think that the higher maxillary–mandibular plane angles indicate a lower tongue-resting position. Was there, however, a correlation between this low tongue position and interdental sigmatisms?

Table IV.—Relation of Sigmatisms and Abnormal Swallows to Occlusions

	Occlusion (200)		*Sigmatisms* (52)		*Abnormal Swallows* (88)	
	per cent	Nos.	per cent	Nos.	per cent	Nos.
Cl. I (29·2°)	28·5	(57)	19·23	(10)	19·3	(17)
Cl. II, div. 1 (29·9°)	48·5	(97)	67·2	(35)	65·9	(58)
Cl. II, div. 2 (24·48°)	12·5	(25)	3·8	(2)	6·8	(6)
Cl. III (28·16°)	10·5	(21)	9·6	(5)	7·9	(7)

Although *Table III* shows a slight increase in interdental sigmatisms in the low tongue position group, this is probably accounted for by the higher average maxillary–mandibular plane angle. The figures do not indicate a preponderance of low tongue-resting positions in the interdental sigmatism group.

3. Occlusal Patterns.—Examination of the occlusal relationships gives us some most interesting information.

Table IV compares the percentages of the different occlusions in the total group with those in the sigmatism group, and shows also the distribution of the abnormal swallows. In brackets may be seen the average maxillary–mandibular plane angles of the different occlusions, and I would ask you to make special note of the differences.

Here we see a very much higher percentage of interdental sigmatisms in Class II, division 1 occlusions than we would expect to see, and a correspondingly high percentage of abnormal swallows. It would not be correct to deduce from these figures that the Angle Class II, division 1 incisor relationship itself is an important factor in the production of an interdental sigmatism. Most of the sigmatisms are accompanied by an abnormal swallow, and we do know that tongue-thrusting swallows, in association with other morphological factors, are important in the aetiology of Class II, division 1 incisor relationships.

Discarding sigmatisms for the moment, I have prepared a table analysing the different occlusions according to the skeletal patterns (*Table V*).

Table V.—Different Occlusions on the Three Skeletal Patterns

		per cent
Sk. I 33·5 per cent of the 200	Angle Cl. I	46·26
	Angle Cl. II, div. 1	38·8
	Angle Cl. II, div. 2	11·9
	Angle Cl. III	2·9
Sk. II 48 per cent of the 200	Angle Cl. I	12·5
	Angle Cl. II, div. 1	70·8
	Angle Cl. II, div. 2	16·6
	Angle Cl. III	—
Sk. III 18·5 per cent of the 200	Angle Cl. I	37·83
	Angle Cl. II, div. 1	8·1
	Angle Cl. II, div. 2	2·7
	Angle Cl. III	51·35

You will remember that the 52 sigmatisms showed a higher percentage on Class II dental bases (57·69 per cent as compared to 48 per cent). Can we not say that this is due, not to the base itself, but to the fact that the Class II dental base contains a very much higher proportion of Angle Class II, division 1 cases? You will see that there are almost twice as many Class II, division 1 incisor relationships on the Class II dental base as on the Class I. We have already shown that the majority (67·3 per cent) of the interdental sigmatisms are related to Angle Class II, division 1 occlusions.

Endeavouring to show that this assumption is correct, I worked out the following:—

1. The total Angle Class II, division 1 occlusions on each of the three skeletal bases.
2. The total Angle Class II, division 1 occlusions with interdental sigmatisms on the three bases.
3. The total Angle Class II, division 1 occlusions without interdental sigmatisms on the three bases.

Table VI shows the result. The three groups of figures on the right-hand side are very nearly identical, and there is no evidence of a higher Skeletal II base percentage with interdental sigmatisms.

Reviewing the whole question of tongue position and maxillary–mandibular plane angle in relation to the interdental sigmatisms, it can be shown that the high correlation between these sigmatisms and Angle Class II, division 1 occlusions will account for almost all the earlier "skeletal" findings.

Angle Class II, division 1 occlusions have an average maxillary–mandibular plane angle of 29·9°, which is probably not significantly

Table VI.—Breakdown of Angle Class II, Division 1 Occlusions

		per cent
1. Angle Cl. II, div. 1 occlusions (total)	Sk. I	26·8
	Sk. II	70·1
	Sk. III	3·1
2. Angle Cl. II, div. 1 with interdental sigmatisms	Sk. I	28·5
	Sk. II	68·5
	Sk. III	2·8
3. Angle Cl. II, div. 1 without interdental sigmatisms	Sk. I	27·2
	Sk. II	69·3
	Sk. III	3·3

lower than the 30·6° on the interdental sigmatism group. There were approximately 17 per cent more Class II, division 1 occlusions in the high maxillary–mandibular plane angle group than there were in the low group.

In concluding this section on interdental sigmatisms we can be fairly certain that:—

1. The skeletal morphology has little, if any, influence in the production of such a sigmatism. Compensatory movements of the tongue and the mandible have been described by several workers: Rathbone (1955), Ballard (1957), Bendiktsson (1958), Morley (1957); and these take care of any skeletal discrepancies.

2. There is an extremely close relationship between Angle Class II, division 1 occlusions and both interdental sigmatisms and abnormal swallows. This statement must not be misinterpreted. It is not the incisor relationship itself which is the cause of the speech defect, but rather the tongue behaviour with which it is associated, and we do know that the latter may well be one of the aetiological factors in producing a Class II, division 1 incisor relationship. In support of this one must realize that almost two-thirds of the Class II, division 1 incisor relationships are not accompanied by an interdental sigmatism.

LATERAL SIGMATISM

There were only 10 lateral sigmatisms and *Table VII* illustrates the skeletal and occlusal distribution. It is difficult to read much from these figures because of the small numbers, but I would ask you to look at the large number of Angle Class II, division 2 occlusions associated with a lateral sigmatism—4 out of 10—whereas Class II, division 2 occlusions form only 12·5 per cent of the total of 200. The low maxillary–mandibular plane angle is entirely accounted for by this preponderance of Class II, division 2's. Frank (1955) states that an open bite in the posterior segment may result in the lateral type of lisp. I think that the common denominator here may be either an increased interocclusal clearance, or the low postural position in Class II, division 2's, described by Ballard (1956).

Table VII.—Lateral Sigmatisms

Sk. I	2
Sk. II	6
Sk. III	2
Angle Cl. I	2
Angle Cl. II, div. 1	3
Angle Cl. II, div. 2	4
Angle Cl. III	1

Average maxillary–mandibular angle 27·5°
Low tongue position in 1 only

I want now to turn from this cross-section analysis and consider the longitudinal problem. Three statements may be made at this stage:—

1. Some sigmatisms improve spontaneously without any relation to treatment, either orthodontic or speech correction.

2. Some appear to improve when the incisor positions improve.

3. Some respond easily to speech therapy, and some are intractable.

Are we able to differentiate between these types at the diagnostic stage, so that we can give a more accurate prognosis both for the sigmatism and the malocclusion, bearing in mind the close correlation between interdental sigmatisms and atypical tongue behaviour? I think we can make some headway towards this goal, and would like to present some case histories.

It must be realized that although speech is normally fully developed at about the age of 5, there is a normal variation. Templin (1957) finds that articulation in general is not essentially mature until the age of 8.

CASE REPORTS

Case C. F. (*Fig.* 3).—Aged 7 years, 11 months when initial models were taken. She had a tongue-thrusting swallow, sucked her thumb, and had an interdental sigmatism. An Andresen appliance was fitted, and when the second set of models were taken there was no lisp, no thumb habit, and a tooth-together swallow with no tongue thrust.

Case R. R. (*Fig.* 4).—Aged 8 years when the first models were taken. There was a thumb-sucking habit, an interdental sigmatism, and a tongue-thrusting swallow. At the time the second models were taken there was a tooth-together swallow, with no tongue thrust and no sigmatism. Speech had improved measurably within six months of fitting the first appliance.

Case L. B. (*Fig.* 5).—Aged 8 years, 1 month when the initial models were taken. She had a tongue-thrusting swallow and contracted the lower lip under the upper incisors. She had a habit of sucking her lip. There was a lip-to-tongue resting posture, and a sigmatism. The

lips were potentially competent. The second models show the result seven months following discontinuance of the appliance. There is now a tooth-together swallow with no tongue thrust, and no contraction of oro-facial musculature. There is no lip–tongue resting posture and the lips are competent. Therc is now no lip-sucking behaviour and no sigmatism.

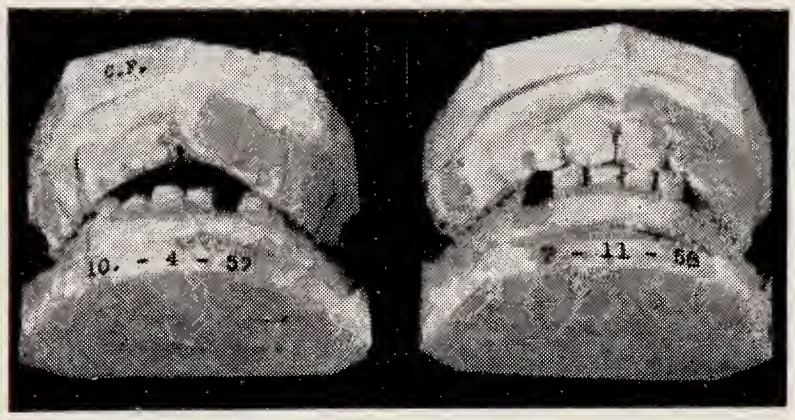

Fig. 3.—*Case* C. F. Models showing reduction in overbite and over-jet at the end of treatment.

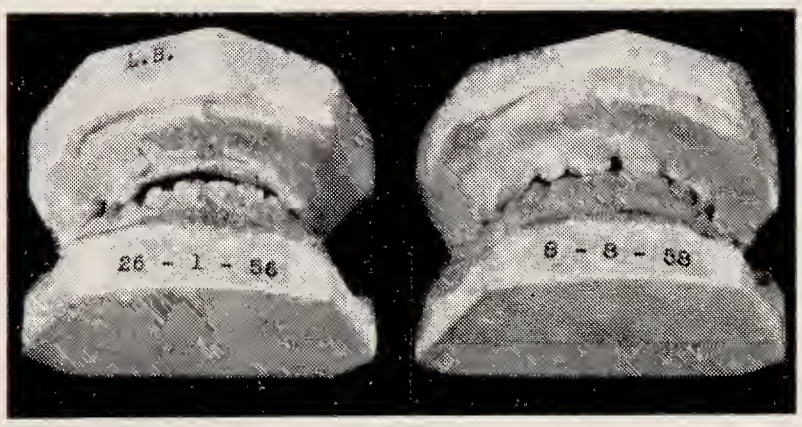

Fig. 5.—*Case* L. B. The final models reflect the improved tongue behaviour following treatment.

Fig. 7.—*Case* P. H. The improved vertical relationship of the incisors was not connected with cessation of a sucking habit.

Case E. T. (*Fig.* 6).—Aged 7 years, 9 months when initial models were taken. The relevant notes from the diagnosis show that there was a tongue thrust on swallowing, with contraction of mentalis and orbicularis oris muscles. There was a tongue to lower-lip resting posture and an interdental sigmatism. The first two fingers of the left hand were sucked persistently. An Andresen appliance was fitted to discourage the habit and try to lessen the ultimate problem. The second models were taken in Jan. 1959, ten months following discontinuance of the appliance. There is now no tongue–lip resting posture, a tooth-together swallow with no tongue thrust. She very occasionally swallows with all the teeth apart, but with no anterior tonguc thrust. Some sigmatism remains with some tendency to move the tonguc forward during general speech.

Case P. H. (*Fig.* 7).—He was just over 11 when the initial models were taken; there was a marked sigmatism with a tongue-thrusting swallow. There were no secondary sucking habits. The lisp was so marked that I advised a course of speech therapy to run concurrently with the orthodontic treatment. However, I didn't get round to

Fig. 4.—*Case* R. R. The improved incisor relationship is especially apparent in a vertical direction.

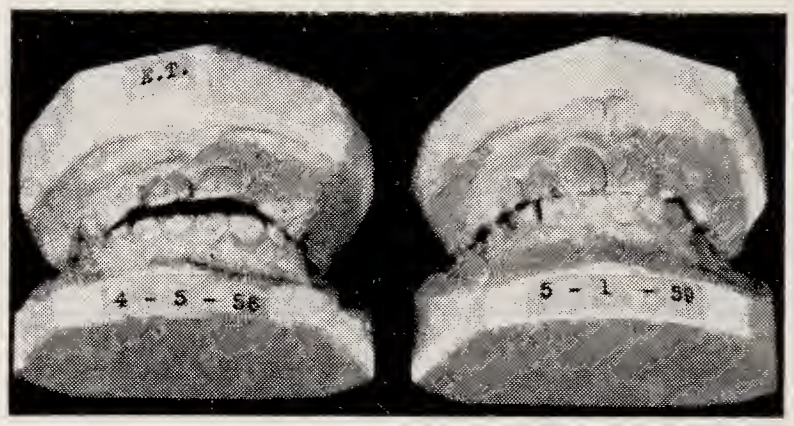

Fig. 6.—*Case* E. T. Models show improvement of anterior open bite during treatment.

organizing this and when the second sct of models were taken on Aug. 20, 1958, there was then no sigmatism. A tongue-thrusting behaviour was persisting, however.

Now two cases without sigmatisms.

Case P. R. (*Fig.* 8).—Aged 10 years, 7 months at time of diagnosis. Marked tongue thrust against contraction of the mentalis during swallowing. Incompetent lip pattern with lower lip to tongue-resting posture. Sucks right thumb. Second models taken Aug. 23, 1958, six months after an Andresen appliance had been discontinued. Hc does not now suck his thumb, and there is a tooth-togethcr swallow with no tongue thrust.

Case P. B. (*Fig.* 9).—This patient was 8 years, 3 months when a deterrent plate was fitted to try to overcome a very persistent thumb-sucking habit. There was a tongue-thrusting swallow. This paticnt had fifteen months of active treatment with this and other appliances, and we had a tremendous job to try to get her to overcome the habit. When the second models were taken there was little or no residual thumb-sucking; there was a normal tooth-together swallow with no tongue thrust.

You will see that in each of these cases (except one) the swallowing pattern appears to have altered. Now I realize that I am not showing you anything new; I am merely trying to demonstrate a possible association of one factor with another.

Each of the foremost workers in this field, Ballard (1955, 1957), Rix (1948, 1953), Hovell (1955), Gwynne-Evans and Tulley (1955) states, or suspects, that some modifications of swallowing behaviour with some types of swallow may occur. Ballard feels that there

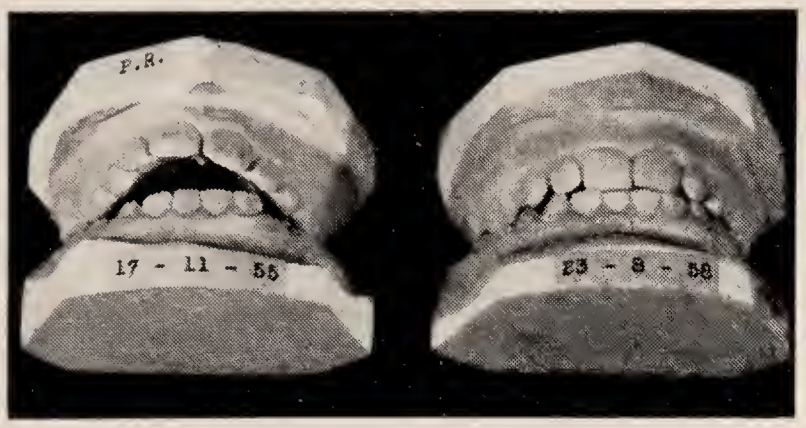

Fig. 8.—*Case* P. R. Models showing that an asymmetrical open bite, a product of thumb-sucking, has been entirely eliminated.

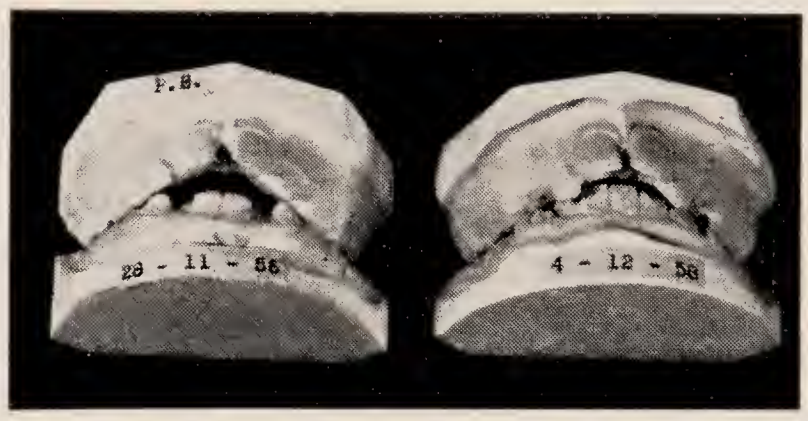

Fig. 9.—*Case* P. B. This case is still under treatment, but there is an improved incisor relationship with cessation of the thumb habit.

are two types of tongue thrust: one which is endogenous and remains after treatment, and one which is a habit activity. Because of the relationship with interdental sigmatisms, I thought it would be of aetiological significance if some attempt could be made to differentiate between these types. Hopkin and McEwen (1957) recognized the present confusion on the subject of swallowing, owing to the great amount of study being carried on. Whilst in no way competent to enter this field of orofacial behaviour, I found from the practical point of view that I could detect no fundamental way of differentiating those thrusts which are going to get better anyway and those which were going to remain. Either could be accompanied by an interdental sigmatism and a lip–tongue resting posture. I must admit to being very much more suspicious of a resting lip–tongue contact when *all* the teeth are out of occlusion. I could, nevertheless, detect varying degrees of intensity of the thrust. This, together with the inclination of the upper incisors, the lip pattern and its behaviour during swallowing, plus any skeletal discrepancy, may allow one to assess the relative importance of the thrust. There did appear to be, moreover, two shining lights: first, the presence or absence of a persisting thumb- or finger-sucking behaviour, and secondly, the behaviour of the tongue *in general* during speech, and not just during the production of an "s" sound.

Of the two types of tongue thrust with the posterior teeth in occlusion, one type, the habit activity, may or may not mature to an improved pattern of behaviour. I think that where a thumb- or finger-sucking habit is persisting, then this serves to delay any maturation that would normally take place. I think also that where an interdental sigmatism is superimposed on this picture, then the development of a normal "s" sound may be delayed in a similar manner. Tongue behaviour appears to improve with the cessation of the thumb–finger habit, and with this improvement goes an improvement in speech. This can, of course, occur without treatment, and in those cases where appliances have been fitted, I in no way attribute the improved tongue behaviour to the appliance directly. The probability is that most if not all of the maturation would have taken place without the appliance. In the case of a child of more mature years, say 8 plus, continuing a severe finger–thumb-sucking habit, and where this is associated with an interdental sigmatism and tongue-thrusting swallow, I think one may be assisting in the process of maturation of speech and tongue behaviour by trying to control the habit.

The use of an appliance in these circumstances will not correct the persistent habit overnight. Where it does correct the habit miraculously then in my opinion it was an error to use it at all. An appliance of any sort designed to accomplish other tooth movements may well act as a deterrent plate.

I do not question the existence of an endogenous tongue thrust, which may or may not be coupled with an interdental sigmatism, and which has a poorer prognosis. It may be that those tongue behaviours not associated in any way with a persisting thumb- or finger-sucking habit have such a relatively poorer prognosis.

There are almost certainly two principal types of interdental sigmatism. I know that many types are described, but I think that in the main these are descriptive terms applied to the resultant sound produced. The great majority of interdental sigmatisms, uncomplicated by other speech defects, improve spontaneously during the growing years. The reason for the fact that many do well during a course of speech therapy is simply that they would have done well anyway.

My card index is replete with cases of both interdental and lateral sigmatisms which have corrected or improved themselves, while I have been waiting to film and record them. With this first type of sigmatism, there is no doubt that once the correct sound has become an integral part of the speech pattern, there is no reversion. This supports the view that the defect is merely a stage in maturation, which may, however, be delayed. The second type constitutes the minority which may persist into adult life, and about which very little is known. These are the ones which are intractable from the speech-therapist's point of view. If a good "s" sound can be obtained by corrective training, then this is probably only maintained by a conscious effort. As Ballard (1955) has stated, the sigmatism tends to return when the individual is under stress or excited. An association with a tongue behaviour where the tongue comes right through between the incisors in speech generally, known as a multiple interdentalism, may well indicate this poorer prognosis.

SEVERE LATERAL SIGMATISM

I want now to mention three severe lateral sigmatisms in Class II, division 2 occlusions which have reverted to normal, or nearly normal, speech. Each case had a deep overbite with a wide interocclusal space. This is associated either with an increased interocclusal clearance or the postured mandibular occlusion described by Ballard (1956).

In each case the lateral sigmatism has improved during the initial phase of treatment when a bite plane was being worn. Each now shows a reduction in the deep overbite without presenting at this stage an increase in the interocclusal space in the buccal segments. It may not be pure coincidence that the above cases showed their improved speech behaviour at the same time as the postured occlusion had been eliminated, but it is sufficiently interesting to merit further and more elaborate investigations.

Table VIII.—Bristol Sigmatisms

Interdental		
Cl. I	5	Majority with reduced overbite or open bite
Cl. II, div. 1	16	
Cl. III	2	
Lateral		
Cl. I	2	
Cl. II, div. 1	6	
Cl. II, div. 2	4	
Cl. III	1	

I have in Bristol 36 sigmatisms which I have been observing, and they are split up as shown in *Table VIII*. Careful assessment of the swallowing behaviours indicates that in many interdental sigmatisms the tongue thrust, whilst usually present, is not vigorous; this would agree with the Eastman analysis, bearing in mind that the latter was initiated more than five years ago, when no differentiation of tongue-thrusting swallows was made. Thirteen of my cases of interdental sigmatism were persistently sucking finger or thumb. A larger proportion of lateral sigmatisms was related to Angle Class II, division 1 occlusions than appeared in the earlier Eastman figures.

Before showing a short film, I want to sum up my present thoughts on the inter-relationship of sigmatisms, tongue behaviour, and occlusions:—

1. Skeletal basc discrepancy in an antero-posterior direction does not produce an actual increase in sigmatisms, and compensation takes place both by tongue and mandibular movements.

2. We have to be very careful in interpreting the high maxillary–mandibular plane angle

results. Certainly an association is shown between these high angles and Class II, division 1 occlusions. There is also an association between a high angle and a low tongue-resting position; there is further an association between Class II, division 1 occlusions and interdental sigmatisms. But whether there is a cause and effect relationship between a high maxillary–mandibular plane angle and an interdental sigmatism is something we are unable to assess.

3. The importance of the tongue in relation to the occlusal plane is then, to some extent, not resolved. I should like to examine the height of the tongue in relation to the occlusal plane on rest position X-rays.

4. Tongue *function* does appear to be important; some form of tongue-thrusting behaviour does seem to accompany most of the interdental sigmatisms; where a definite "th" sound is produced as opposed to an air escape, it is less likely to be coupled with an atypical swallowing behaviour.

5. Tongue behaviour improves especially when associated with secondary sucking mechanisms, thumb- or finger-sucking, which are brought under control. If there is, superimposed on this picture, an interdental sigmatism, there is a concurrent improvement in speech.

6. A persistence of the thumb- or finger-sucking habit may serve to perpetuate the other disorders. The prognosis for improving an incisor relationship is very much poorer in the face of a continued tongue and thumb behaviour. But this is only at one stage in the development of the occlusion; later on, the prognosis for correction may have improved considerably.

7. One can be less definite about those interdental sigmatisms not accompanied by secondary sucking mechanisms. I have several which have corrected themselves during the course of orthodontic treatment. There are, of course, other aetiological factors which I have not discussed, and which must be taken into account. Deafness and intelligence are also important.

8. Lateral sigmatisms may or may not be associated with a tooth-apart swallow, that is when all the teeth are out of occlusion, but they are not related to a forward tongue thrust. A lateral sigmatism and a forward tongue thrust present in the same case must be considered quite separately. I have several such cases in Class II, division 1 occlusions, when the tongue behaviour improved as the thumb-sucking habit ceased, the lateral sigmatism remaining. When a lateral sigmatism is associated with a Class II, division 1 occlusion, the cause of the incisor relationship must be ascribed to some other factor than a forward tongue thrust, unless the two coexist.

9. Lateral sigmatisms may often be associated with Angle Class II, division 2 occlusions, but are not necessarily so. The existence of more than one type of lateral sigmatism cannot be ruled out.

10. I make one final point. All our cases should be subject to a period of observation before commencing treatment. We must view them as part of a progressive development, and not as a set of plaster casts. In spite of what has been said above, I do *not* fit a great many deterrent plates or Andresen appliances. If a case under six-monthly review is improving, and any habit gradually being controlled, I am content to discard this aspect of the case and allow further development to take place.

FILM

The patients were filmed initially to provide a visual record of both tongue and mandibular movements in speech. It is intended to refilm the same patients later, and this will enable a comparison to be made. Alteration in movements of both tongue and mandible can be checked and, probably more important, we shall find out which of those atypical behaviour patterns persist.

Posturing forward in speech is shown in both Class II, division 1 and Class II, division 2 type occlusions. Several patients are shown to illustrate the tongue behaviour in producing an ad-dental sigmatism. Two cases show an excessive activity of the tongue in multiple interdentalism. There is a comparison of two types of tongue behaviour in fraternal twins, both with an interdental lisp. One of these twins illustrates well an asymmetry of tongue

movement which I feel certain is related to the persisting finger-sucking habit.

CONCLUSION

In conclusion I would like to state that this is the beginning of a research project, and not the end. In view of the small numbers, the investigations carried out so far must be considered pilot investigations, and further work along these lines is proceeding.

I feel that a more complete assessment of the tongue behaviour in the wider field of speech, in addition to that shown in the act of swallowing, will give us increased information on the relative importance of the atypical behaviour patterns. It may also help us to clarify the diagnostic importance of the various types of lisp.

Acknowledgements.—May I thank Professor Ballard and Miss E. K. Bond especially, of the Eastman Dental Hospital, for much help and encouragement, and Mr. Morgan for producing most of the slides; Professor Darling and the University of Bristol Dental School, for providing valuable facilities for filming and additional slides. Finally Miss K. Coleman and her associates on the staff of the Speech Clinics in Bristol, for much useful discussion, and facilities to examine and record patients under treatment.

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DISCUSSION

Professor C. F. Ballard congratulated Mr. Blyth on his paper, the clear analysis of the cases, and the presentation.

Mr. Blyth had stated in his opening paragraph that it was generally accepted that dental irregularities were not a direct cause of sigmatism, and where the two were present in an individual some common cause must be found. His own experience about 5 or 6 years ago had, however, shown that this was not so, and Miss Bond had informed him that outside a small circle of speech therapists associated with orthodontists it was still not generally accepted that dental irregularities were not a direct cause of sigmatism. He thought that view was due to their belief, in some way or other, that the acquisition of correct articulation was the same process as the learning of skilled movement.

Those who studied orofacial behaviour did not believe that the patterns of activity that they saw were in the nature of learned skilled movement, because, in fact, they did not see them change. An individual had a typical morphology and pattern of activity which he would adapt for speech.

In that respect he would like to discuss the use of the word "maturation". Mr. Gwynne Evans and perhaps Mr. Rix would also agree that initially the fundamental mistake had been made of thinking in rather vague terms of maturation. It had been thought that the infant was born with certain patterns of activity, and that as part of its natural development those patterns were going to change to something fundamentally different. He did not think, in fact, that such a view could be accepted to-day.

The changes that one did see, and about which Mr. Blyth had been talking, were in the nature of a modification. The word "maturation" could be used, but they were modifications which occurred in a very high proportion of the malocclusions that were seen over the age period from the time of the eruption of the incisor teeth through to about 11 years. There were no fundamental changes in tongue or lip behaviour in these cases, but very often open bites associated with tongue-thrusting over the period mentioned would close up without any orthodontic treatment being required.

Mr. Blyth's research work really originated from the general concept on the basis that people had characteristics of behaviour which they modified for speech, according to how they perceived the sounds of our language.

He thought one of the really significant points was that it had been shown that sigmatism was associated more with the Class II, division 1 malocclusion than with a low tongue position associated with high maxillary–mandibular plane angle, or with the postnormality of the dental base. While that required further research, to his mind it would indicate a reason for some of the adaptive behaviours that were seen. There was the necessary lip to tip of tongue contact to seal off the mouth, to produce a seal across the increase of overjet, which so disturbed lip and tongue behaviour that the individual, at least over the age period of 6 to 11 years, could not adapt

and produce sounds properly. The child learnt to do it, but it took time.

He would suggest, therefore, that a lot of these sigmatisms were not associated with the endogenous tongue thrust at all, but with a habit activity. That would be consistent with their ideas.

Miss Bond had given a point which supported this view, which was that with some of the articulatory defects the majority of speech therapy training would not be an endeavour to get the individual to acquire skilled movement with lips and tongue but an attempt to cultivate the perception of what that required. In other words, the training was in the perception of sound so that the individual would modify his own behaviour quite subconsciously to produce the correct sound. He did not have to be taught to use his tongue and lips in any particular way, and in fact research was going on which suggested that in a speech therapist's attempt to teach an individual exactly how to produce a particular sound the effect would possibly be to render it even more difficult for that individual to learn to produce a sound correctly. That was the research in which Miss Bond, Mr. Blyth, and one or two others were interested at that moment.

With regard to the finger- and thumb-sucking, the degree of open bite and its significance in relation to improvement, he rather reluctantly agreed with Mr. Blyth. He thought that in the case of a very large open bite which would be asymmetrical because of the finger- and thumb-sucking, if the child in fact did persistently suck a finger or thumb it would for some reason or other indicate that the prognosis was likely to be poor. He was not prepared to give any explanation at that stage, because he thought it required investigation. It had been suggested that there might be an hereditary basis for finger- and thumb-sucking. That was not necessarily the only aspect of that relationship, and it certainly needed more research.

The posturing cases were very interesting; again this was an adaptive mechanism. It would seem necessary that at least for the production of English speech the front teeth should move up and down close to one another without there being any labio-lingual space. Whenever an individual, owing to an asymmetric jaw relationship, had a gap or labio-lingual space in relation to the upper incisor teeth, inevitably posturing downwards and/or forward to eliminate that space was noticeable. If an individual did posture in that way, there was a gap between the cheek teeth which might produce lateral sigmatism.

Why did some have lateral sigmatism and others not? Again it was possible that it was due to their auditory perception. They might not realize that they were lisping, and that was where the speech therapists came in. Again, if the overbite was eliminated the space was eliminated, as Mr. Blyth had pointed out, to a certain extent. The gap at least between the cheek teeth was eliminated, and the sigmatism could disappear.

He thought Mr. Blyth had pointed out the way for considerable and useful research which, using orthodontic concepts, would be of value to the speech therapy world.

Mr. J. R. E. Mills said that as he understood it the interdental sigmatism was the ordinary lisp with the "th" replacing the "s" sound. While this could be associated with an anterior open bite, it was sometimes seen with a mild increase in overjet and a complete overbite. Had Mr. Blyth any comments to make?

One of our problems was to differentiate the endogenous tongue thrust from one which was merely a habit. His own clinical impressions supported Mr. Blyth's statement that it associated with a multiple interdentalism. Mr. Blyth had said these patients had a lip-to-tongue resting posture with the teeth apart; could Mr. Blyth enlarge on this?

Miss L. M. Clinch, with regard to tongue thrust, said that it seemed to her that there must be two completely different types. Mr. Blyth had said that tongue thrust was reduced as the sucking habit was controlled. Could not the sucking habit produce an incisor open bite, and the tongue push through this space? If, however, the incisor overbite was corrected at the same time as the sucking habit was controlled the tongue could not bulge through the incisors. In other words, the tongue thrust could be secondary to the sucking habit.

While she realized that that was obviously not the endogenous type of tongue thrust, she would like to ask if Mr. Blyth would agree that there was a secondary tongue thrust which could actually occur as a result of the open bite caused by the sucking habit. It was her impression that this could happen, and she would have thought that the tongue thrust would not be associated with sigmatism in that case.

Mr. J. H. Hovell said he felt the ability to differentiate between an endogenous pattern of behaviour and a habit activity was all-important.

There were two things that one could take into account, the first being that an endogenous behaviour was always accompanied by a much more powerful circumoral contraction of the orbicularis oris muscle than in a habit activity. It was in such a case that difficulty was found in trying to examine a tongue thrust in the classical manner of parting the lips. The very powerful contraction of the circumoral muscles he thought, however, was associated with an endogenous tongue thrust. Secondly, a tongue thrust in a Class I or mild Class II dental base relationship was much more likely to be an endogenous one than was one occurring in a frank Class II dental base relationship. The latter was likely to be a habit pattern of behaviour as a result of forward positioning of the tongue, either to obtain a seal against the lower lip or to get contact with the upper incisor teeth. He therefore always taught, contrary to what many people said, that the case of the Class II, division 1 on a normal dental base relationship was the one with the poor prognosis. In these, one frequently found the endogenous behaviour which was not correctable and did not correct itself.

In connexion with the high Frankfort–mandibular angle, one was more likely to have an incompetent lip morphology with a post-normal dental base relationship, the upper incisors being less likely to be controlled by the lower lip. Had these points been checked in any way during the investigation?

Mrs. Jackson said she had been interested in the subject since her colleagues at Manchester said she had a sigmatism. She had tried, and failed, to eliminate it entirely from her speech and thought this was because she had an anterior open bite. It seemed that although an existing sigmatism might be minimized it could not be eliminated unless the open bite condition resolved. Spontaneous cure of a sigmatism only seemed to occur when the open bite and tongue-thrusting swallow was of a transient type, as in the mixed dentition before and during incisor eruption.

Mr. J. S. Beresford said that he did not think Mrs. Jackson needed to worry about where the lip and tongue went.

Mr. H. E. Wilson said it was known that discrepancies occurred between certain parts of the facial skeleton and soft tissues, and he sometimes suspected that what appeared to be endogenous tongue behaviours were, in fact, discrepancies between the size of the oral cavity and the size of the tongue. This was a subject rarely, if ever, discussed and would be very difficult to prove or disprove, but some children did appear to have very large tongues.

Mr. Blyth said that it was necessary to keep the patient under observation for a long time, but a proportion of the children would fail to return for one reason or another and it would be difficult to build up ciné records of a sufficient number of children. Six or 12 months or even 2 years of observation and ciné records before treatment would be most useful in deciding changes that occur in the oro-facial musculature due to maturation, or following treatment.

Professor C. F. Ballard said that Mr. Blyth had shown some low tongue positions in his X-ray slides. One way of checking, and in fact of answering, Mr. Wilson's query, was to note in those tongue-thrusting cases the position and posture of the tongue.

A tongue which had a thrusting behaviour, whether it was endogenous or not, dipped down.

In order for Mr. Wilson's suggestion to be sound, in all cases there would have to be found a tongue completely filling the oral cavity inside the mouth. This was found in some cases, and quite obviously it was a point for observation and investigation. It was interesting, however, that when the overjet was reduced, in many cases the tongue changed its resting posture.

Mr. W. J. Tulley said he was sure that this was the beginning of a most important work, because a "serial story" technique was the only way in which the problem was going to be understood. He thought too much was said too dogmatically and too early about the subject.

The Chairman said he was sure that the amount of discussion that the paper had stimulated was a measure of its success. He would ask Mr. Blyth to reply.

Mr. P. J. Blyth thanked Professor Hallett and Professor Ballard for their very kind remarks. He agreed that a great deal was yet to be done, and he, personally, would like to see Professor Ballard's remarks in print before replying to them.

With regard to Mr. Mills's point about ad-dental sigmatism, the points he himself had been trying to make were that the ad-dental sigmatism could be related to any occlusion and was not really necessarily related to an abnormal swallowing behaviour. He would still find it difficult to attempt to differentiate between the thrusts. In many of them he had made the attempt and recorded it in his diagnosis. It remained to be seen what happened.

When he had said that he was very suspicious of a lip–tongue contact with the teeth apart, he had meant with all the teeth apart, posterior teeth as well, and the sort of habit with the tongue resting through between all the teeth. He was suspicious of that type because he did not think the answer to it was known.

He would like to thank Miss Clinch for her remarks, and would agree most definitely that there were two types of tongue thrusts. With regard to the secondary type of tongue thrust he did not think it was necessarily the *result* of the habit. It would be difficult to say which came first.

He would like, also, to thank Mr. Hovell for his comments, and would agree that an attempt must be made to differentiate between the swallows. He thought there were four or five points which had to be answered. First of all, what happened to the posterior teeth at the moment of swallowing? Were they apart or together? Also, what happened to the tongue, anteriorly? Did it thrust, or did it not?

Again, if the posterior teeth were apart, was there a very active anterior thrust, or was it just coming through to meet the lips? He would certainly like to assess the lip morphology, because if the lips were incompetent then they were going to have to contract in any case, normally, to effect a lip seal during the moment of the swallow. The amount of contraction needed for that would have therefore to be discounted. Was there an excess of contraction, then, to meet an anterior tongue thrust? Some incompetent lips of course did not contract at the moment of swallowing.

Further, one had to watch a child swallow dozens of times before getting the true picture of what that child's swallow was really like, and at that stage one could relate it to the occlusion, see what effect it was having, and whether it was perhaps a cause or, if associated with other factors, a result.

He was afraid he had not quite grasped the purport of Mrs. Jackson's remarks about the lip–tongue contact, which she had tried to eliminate. He would agree most certainly that there was an endogenous tongue thrusting with lip–tongue contact and interdental sigmatism which might be improved but which would not get better. He thought it was terribly difficult at this stage to try to differentiate between those types and other types. The association of the habit was something which would be helpful.

He would like to thank Mr. Wilson for his remarks. Professor Ballard had really answered his question.

With regard to Professor Ballard's point about the position and posture of the tongue, there were 106 cases where that low tongue position had been found. They were related to all occlusions: Class III; Class II, division 1; and Class II, division 2. He had checked on the number, and while he had no details with him he could state that they had been very nearly the same as the total group, with a slight increase in the Class II, division 1 cases. There had been one or two Class II, division 1 cases in which the tongue position had altered over the period of the orthodontic treatment. Almost all of the cases had been assessed on several X-rays and not just one. The tongue position had been found fairly constant, except in two or three cases in which it had altered and which were being followed up.

He would like to thank Mr. Tulley for his remarks. He was certain that it was correct that one could get a better answer by observing the continuity of the cases over a period of years. It had been with that idea in mind that filming of his patients had started two years ago. The film was not complete, the titles having been put on for this particular paper. The filming was going on continuously and some of the cases were approaching the stage at which they would be refilmed. When that stage was reached they would be in a position to compare the behaviour patterns. In exactly the same way, all cases with lisps were being recorded, and an endeavour made to keep as full a note as possible of the behaviour patterns so that later on it would be possible to look back and get useful information from the total combination of the photographs, the recordings, and the notes.

IMPACTED SECOND MANDIBULAR MOLARS

By **DOUGLAS MUNNS**, L.D.S. R.C.S. (Eng.)

As several cases of impacted permanent second mandibular molars have been discovered during routine orthodontic examinations, my interest has been aroused. Taking into account the teeth of both the deciduous and permanent dentitions, impactions of the mandibular second permanent molar occurs very infrequently; of the various workers who have investigated the condition, the highest figure recorded is 0·5 per cent of all impactions under review by any one author.

Several cases of these impactions have been reported over the past ten years but with one exception (Jackson, 1951), all have referred to gross impactions and not the mild mesioangular impaction under discussion in this paper. In 1952 Adamson did discuss "The problem of impacted teeth in orthodontics" but makes no mention in his paper of the impacted second permanent molar teeth. No other references can be found to this anomaly as it affects orthodontic procedures.

tends to look for it in every patient entering the surgery, and if you are not careful you could see a tendency towards an abnormality when it is not really present, and for this reason

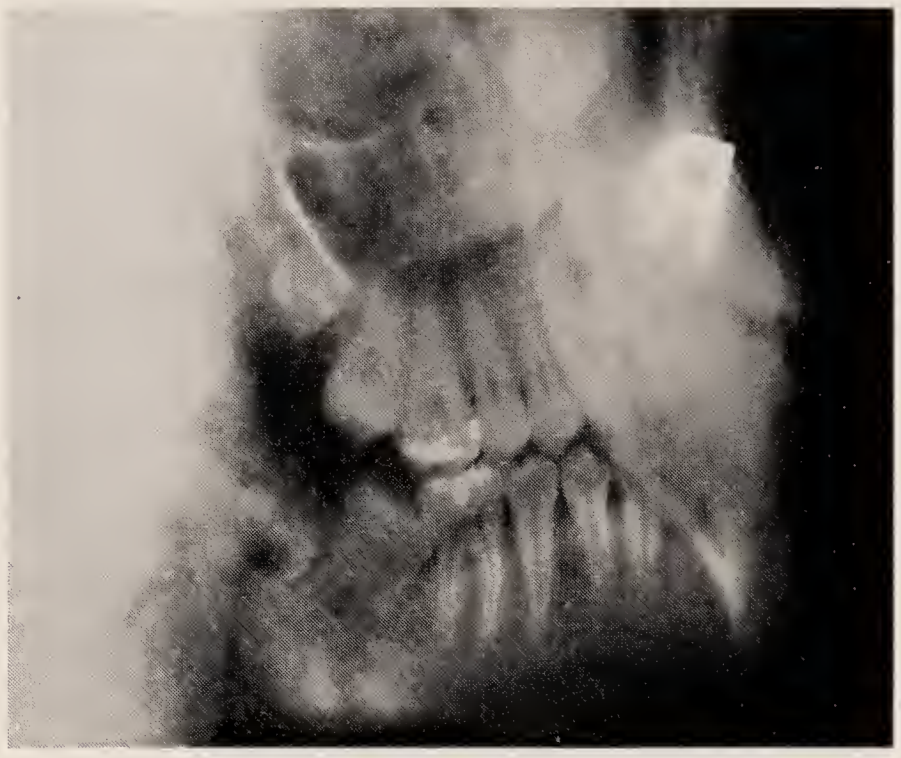


Fig. 1.—*Case* 1 at 13 years 6 months.

Fig. 2—*Case* 2 at 11 years 2 months.

In presenting the following cases I am very conscious of two things: the first is that having discovered an abnormality in one patient, one several doubtful cases are not included in this series; the other is that angulation on radiographs can be very deceptive and can give the

Given at the Manchester meeting held on April 17, 1959.

appearance, due to overlapping, of an impaction, and although only one view of each case is printed here, more than one view has been taken to eliminate this possible error. I hope

Fig. 3.—Study models, *Case* 2. *Top*, before extracting $\overline{6|6}$; *bottom*, 10 months after extraction.

you will not find me guilty of the former in the following cases. I propose not only to consider what bearing the facts have on the development of the mandible and the forward drift of the teeth as described by Brash (1952) and others, but also what influences the possibility of impacted second molars later should have on our treatment plan.

We know that during eruption the lower molars rotate in an arc upwards and forwards, and I would suggest that in many cases they appear to almost slide up the distal aspect of the first molar as development proceeds.

CASE REPORTS

Case 1.—*Fig.* 1 shows a mesio-angular impaction of the right mandibular second molar, at the age of $13\frac{1}{2}$ years, which had given some slight pain about two months before this X-ray was taken. After much discussion with the father, a dental surgeon, this second molar tooth was removed as although there was a danger of injuring the developing third molar and therefore the extraction of the first molar would have been the easier course to adopt, it was considered that the second molar would then never have erupted into a good position and so there would be considerable loss of occlusion on this

Fig. 4.—*Case* 3 at 15 years 3 months.

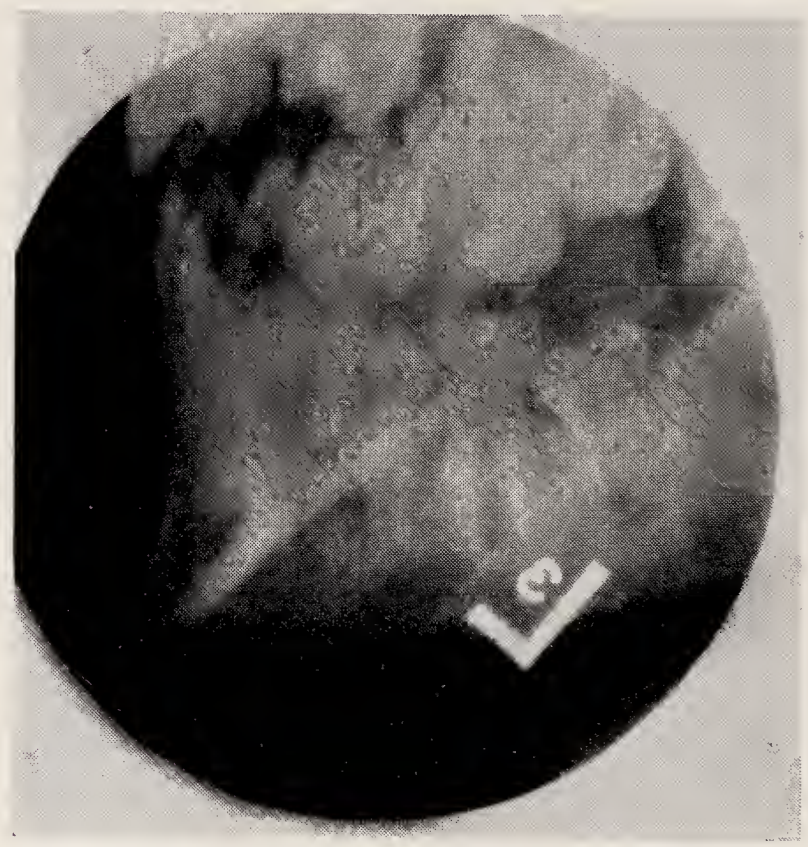


Fig. 5.—*Case* 4 at 13 years 3 months.

side of the mouth. I think this case illustrates the difficulty that one is up against when one is faced with an impacted second molar in the surgery when orthodontic intervention is no longer possible. His father tells me that all his deciduous teeth were lost naturally, except both maxillary canines and second molars, but even these were only extracted a few months before their permanent successors erupted.

Case 2.—This patient, aged 11 years 2 months, was referred to me by the school E.N.T. surgeon as he could find no cause for the severe pain the patient had in both her ears over a considerable period of time. On examination of the mouth, there were no carious teeth, but there was a very irregular bite on the molar teeth, and X-rays (*Fig.* 2) showed impacted second mandibular molars on both sides of the mouth. Here again, there is little in the past history to help us as all the deciduous teeth, with the exception of the two maxillary first deciduous molars, were lost naturally, although there was a space of some two years between the shedding of the left mandibular second deciduous molar and the eruption of its permanent successor. It was decided to extract the two mandibular first molars, and *Fig.* 3 shows position of teeth before treatment and ten months afterwards (the $\underline{6}|$ was lost due to caries). I am not so sure that even in this case it would not have been wiser to extract the impacted second molars. Could this deformity have been prevented if an earlier diagnosis had been made and, say, all first permanent molars removed several years earlier?

Case 3.—Another example (*Fig.* 4) of impacted second molar in a patient aged 15 years 3 months. There were no symptoms in this case and the abnormality was only found on routine examination of the mouth.

Case 4.—In this case (*Fig.* 5), a patient aged 13 years 3 months, we have a definite history of an early loss of deciduous teeth and definite overcrowding in the premolar regions. Is this a case where the first molar has tilted forward owing to the early loss of the deciduous teeth, but when the permanent teeth have erupted the force of these teeth has caused the first molar to upright again and so "catch" the second molar beneath the distal part of the crown? *Fig.* 6 shows lower models at 13 years 3 months, 14 years, and 14 years 8 months; no lower appliances have been worn.

Fig. 6.—Lower models, *Case* 4. *Top left*, at 13 years 3 months; *top right*, at 14 years; *bottom*, at 14 years 8 months.

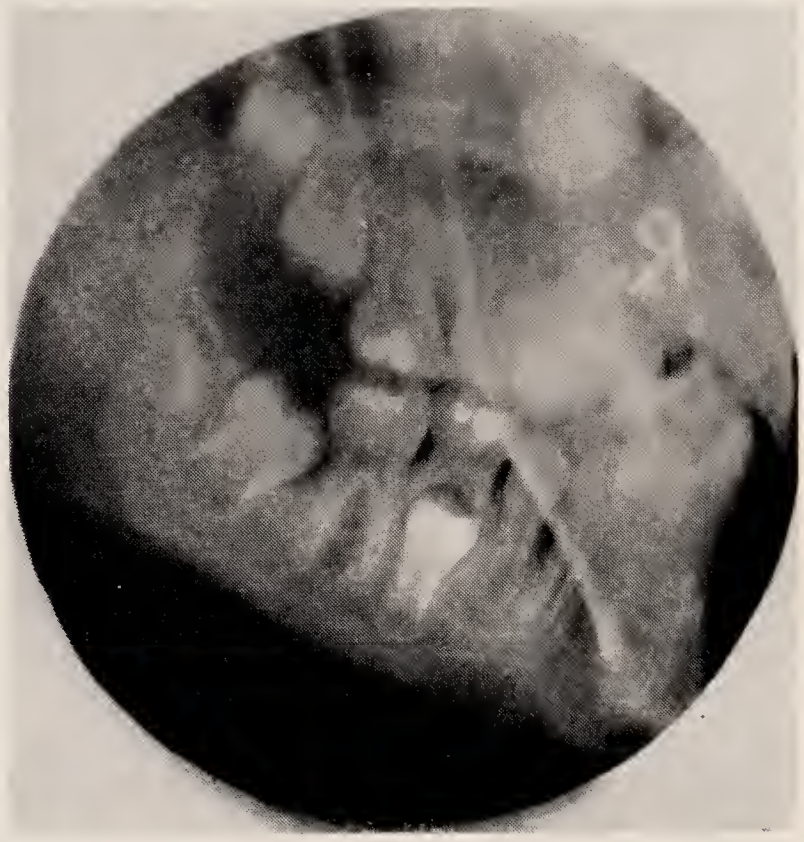
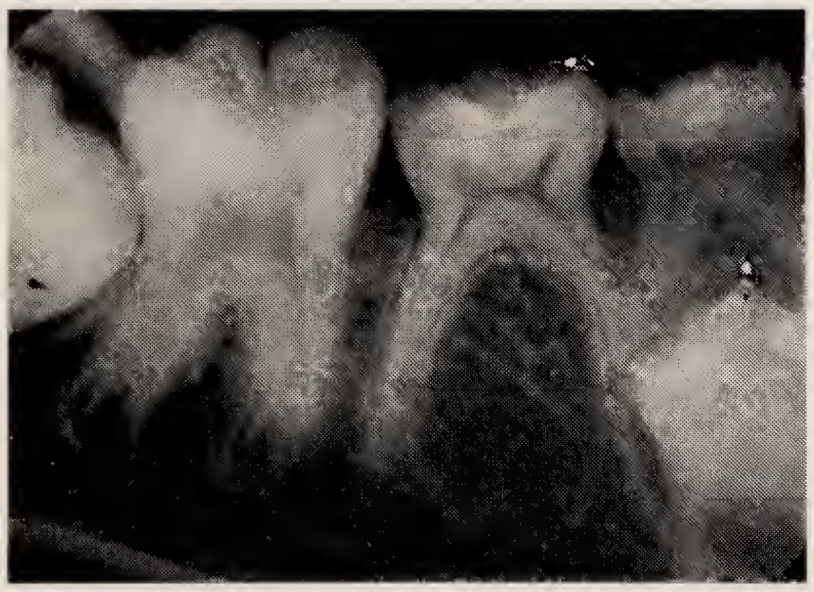


Fig. 7.—*Case* 5 at 10 years 6 months.



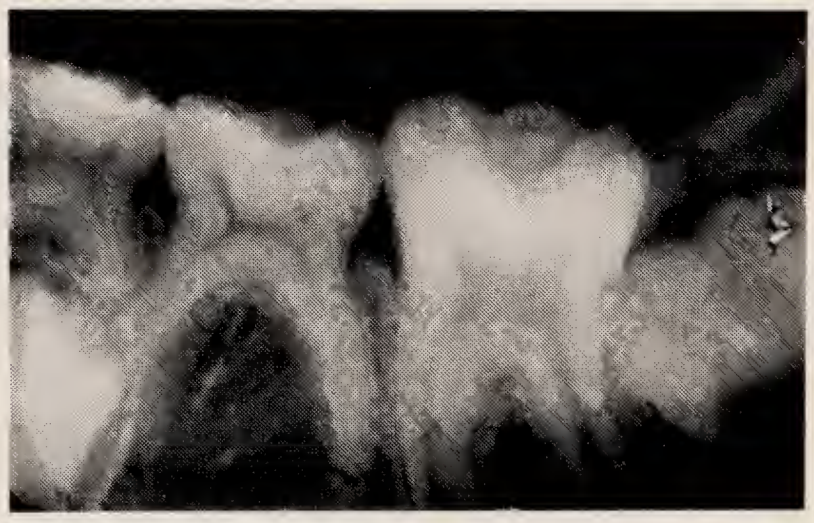


Fig. 8.—*Case* 6 at 8 years 10 months.

Case 5 (*Fig.* 7).—A little girl, aged 10 years 6 months, with a rather similar impaction to the previous case. She has a history of early loss of deciduous molars on this side of the mouth. There is no impaction on the left side.

Case 6.—This case is of interest, as I think the abnormality could have been corrected if the deciduous second molars, having no successors, had been extracted

when X-rays (*Fig.* 8) were taken at the age of 8 years 10 months. However, when I first saw him 16 months later (aged 10 years 2 months) he had impactions of both second molars (*Fig.* 9). Will the removal of the second deciduous molars now allow the occlusion to be corrected

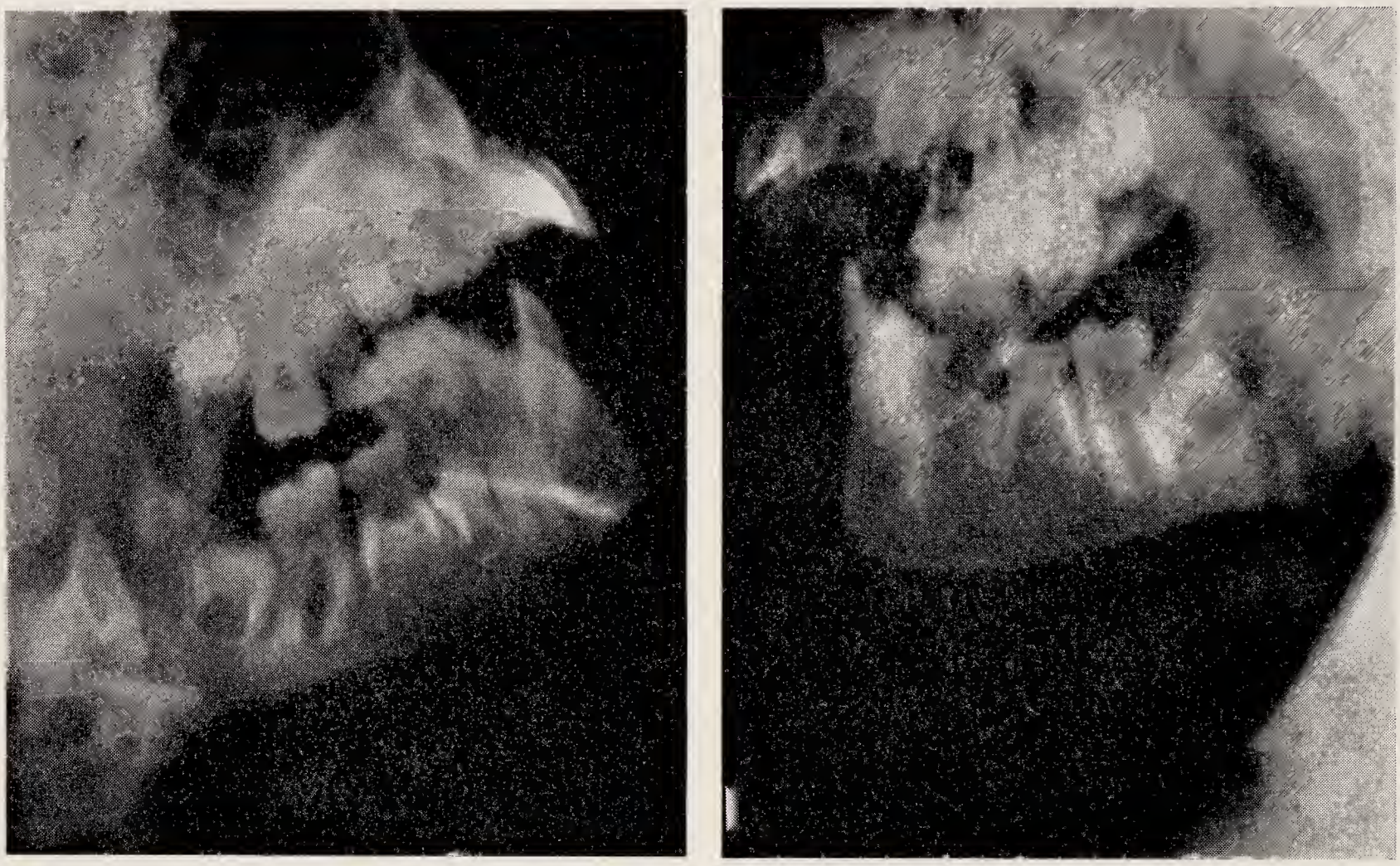


Fig. 9.—*Case* 6 at 10 years 2 months.

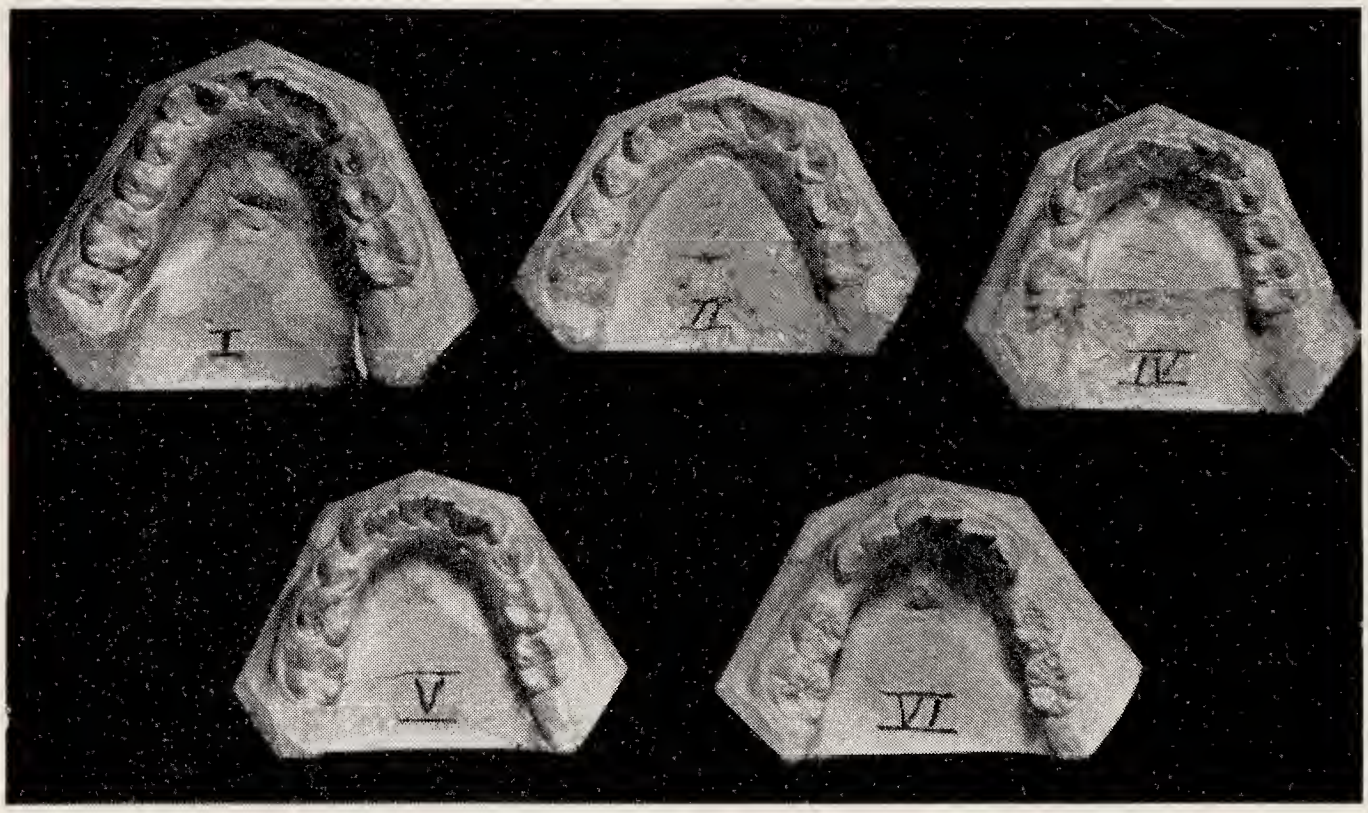


Fig. 10.—Original lower study models of *Cases* 1, 2, 4, 5, and 6.

or are we going to have tipped first and second permanent molars with permanent periodontal damage?

DISCUSSION

I think that both the lower models (*Fig.* 10) and the summary *Table I* show that there is a definite connexion between the impaction of the teeth concerned and overcrowding in the jaws. There are, I suggest, several possible causes for these impactions:—

1. Owing to the overcrowding, the teeth have not migrated forward to the desired degree, with the result that there is insufficient room for the developing second molar and, owing to its general line of growth, it has

become impacted against the distal aspect of the first molar. I think that overcrowding in the maxilla is of equal importance as overcrowding in the mandible in these cases in that locking of the bite has prevented normal tooth movement.

2. Once the second deciduous molar has been shed, or extracted, there has been a forward movement of the first molar, but when the premolars have erupted there has been a slight backward tilt of the first molar, and again the developing second molar has been caught under the distal part of the crown of the tooth in front.

3. In three of these cases (50 per cent) the third molar is either missing altogether or is just a rudimentary tooth, whilst in *Case* 2 there is likely to be a severe impaction. Is this of developmental significance in these individuals in that there is now no room for these teeth? Indeed, development is such that the second molars are now impacting.

I am not suggesting that diagnosis in these cases is easy, for in *Fig.* 11 we have an example of what, at the age of 10 years 6 months, looked as if it might well be an impaction but at the age of 13 there is a completely different picture (*Fig.* 12). Whilst it now appears that the third molar will be impacted, vertical growth of the alveolus is still going on and it may well be that this tooth will eventually erupt normally.

Fig. 11.—Position of teeth at 10 years 6 months.

Fig. 12.—Same patient as *Fig.* 11 at 13 years.

Table I.—Summary

Case No.	Age	Class	Impacted Teeth	History of Early Loss	Overcrowding in Lower In. Region	Overcrowding in Upper In. Region	Overcrowding in Lower Pre. Region	Probable Impaction 8
1	13.7	I	$\overline{7}\vert$	$\frac{EC\vert CE}{D\vert D}$	No	Slight	No	No
2	11.2	I	$\overline{7\vert 7}$		Slight	No	No	Yes
3	15.3	I	$\overline{7}\vert$	—	—	—	—	No
4	13.3	I	$\overline{7}\vert$	Yes	No	No	Yes	Absent
5	10.6	I	$\overline{7}\vert$	No	Yes	Yes	Possibly	Rudimentary
6	10.2	II (1)	$\overline{7\vert 7}$	$\overline{D\vert D}$	Yes	Yes	Yes	Absent

Another case has recently been brought to my notice where impacted second molars were extracted at 15 years of age and now at 19 years, there is a mesio-angular impaction of one of the third molars! In 1956 Bjork, Jensen, and Palling showed that to some extent it was possible to determine whether third molars were likely to be impacted or not; on the other hand Smith (1957) has shown that by extracting the second molar one cannot guarantee a good position of the third molar.

Whether or not it will be possible in the future to draw any similar conclusions in regard to impacted second molars it is impossible to determine from this short series of cases.

SUMMARY

Six cases of impacted second mandibular permanent molars have been reported and the cause of this anomaly and its possible influence on orthodontic diagnosis and treatment planning discussed.

Acknowledgements.—I am grateful to the North-West Metropolitan Regional Hospital Board and to the Northern Group Hospital Management Committee for their co-operation in the preparation of this paper.

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DISCUSSION

The President said he wished to thank Mr. Munns for putting the problem before them and discussing certain cases. It was astonishing how frequently a problem presented itself when one became interested in it.

Mr. D. A. Dixon thanked Mr. Munns for an excellent series of cases. He was interested in impacted first molars, and thought they presented many similar problems. All the cases referred to were in the lower jaw. First molar impactions also occurred in the upper jaw especially in the mixed dentition. The problem of crowding was present in most cases, but not in all. Some cases showed spacing of the anterior teeth, and deciduous molars or pre-molars, with impactions at the back of the mouth.

Mr. G. C. Dickson thanked Mr. Munns for an interesting paper. Presumably an answer was wanted to the question, "Has it any developmental significance?" He could answer that from his own limited knowledge: for two reasons, it could not have. First, there could not be any evaluation in the matter of selection and the closest investigation seemed to show there was no natural selection on the grounds of impaction of second molars. Secondly, the period during which malocclusions had been under investigation (from Anglo-Saxon times) was far too short in connexion with evolutionary changes to make any difference at all.

However, it might be said that the shortening of the dental arches and the occurrence of overcrowding and impaction in various forms could be attributed to lack of natural selection and the result of racial hybridization, which gave a wider range of variation in the size of teeth and the dental arches. Those variations were not eliminated by selection but did persist.

Mr. E. K. Breakspear said that he, too, would like to congratulate Mr. Munns, whose list of causes was a good one. But a further item might be added to that list—namely, appliance treatment. It was important to ensure that the second and third molars were kept under observation when any appliance was inserted to maintain or increase premolar space in the lower arch.

Mr. D. Munns, in reply, thanked the meeting for their reception of the paper. They all attended for the purpose of learning as much as they could, and he had certainly learnt something from the discussion. The only matter he proposed to answer was that raised by Mr. Breakspear concerning appliances. None of the cases in question had worn any appliance up to the time when he saw them. Whether they should have done so or not was another matter. When we see impacted second molars occurring at the end of orthodontic treatment, then we shall have to start thinking again.

TREATMENT OF A CASE OF ANGLE CLASS II, DIVISION 1 MALOCCLUSION, COMPLICATED BY GROSS OVERCROWDING*

By **R. T. BROADWAY**, M.D.S. (Lond.), F.D.S., D.Orth. R.C.S.
Orthodontic Department, Eastman Dental Hospiatl

CASE REPORT

THIS patient, aged 10 years (*Fig.* 1 A), was referred by his general dental praetitioner to the Eastman Dental Hospital for orthodontie treatment.

His orthodontie diagnosis was as follows: "He has a Class II dental base relationship with an Angle Class II, division 1 type of maloeclusion, complieated by gross overerowding in both upper and lower arches (*Fig.* 1 B). All four bueeal segments are forward in relation to the labial segments. The lower eentral ineisors are very proclined, and the lower lateral ineisors are lingual to them. The upper eentral ineisors are also proclined, and the upper lateral ineisors have erupted palatal to them: the left upper lateral ineisor is also in lingual relation to the left lower eentral ineisor. The upper first permanent molars are rotated forward and the upper seeond premolars have erupted palatally. The upper left deeiduous eanine and the lower seeond deeiduous molars are still retained, and the upper permanent eanines and the lower seeond premolars are unerupted. It was also noted that the elinieal erowns of the lower eentral ineisors were long and that the gingival reeession was most marked on the left lower eentral ineisor, whieh was in traumatie oeclusion with the left upper lateral ineisor.

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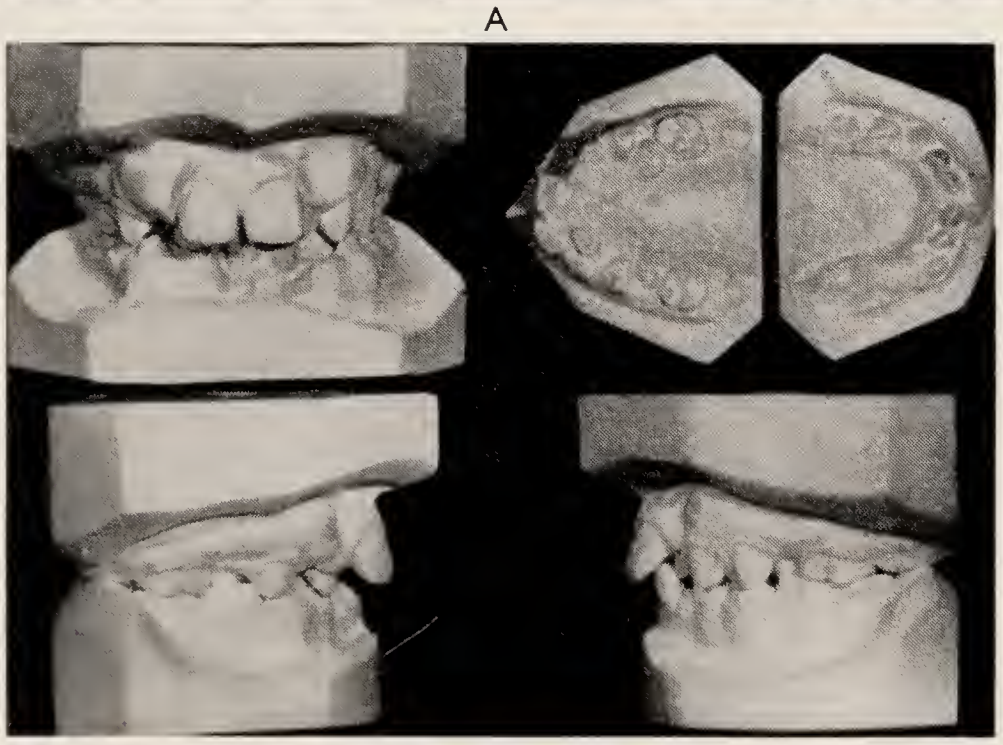

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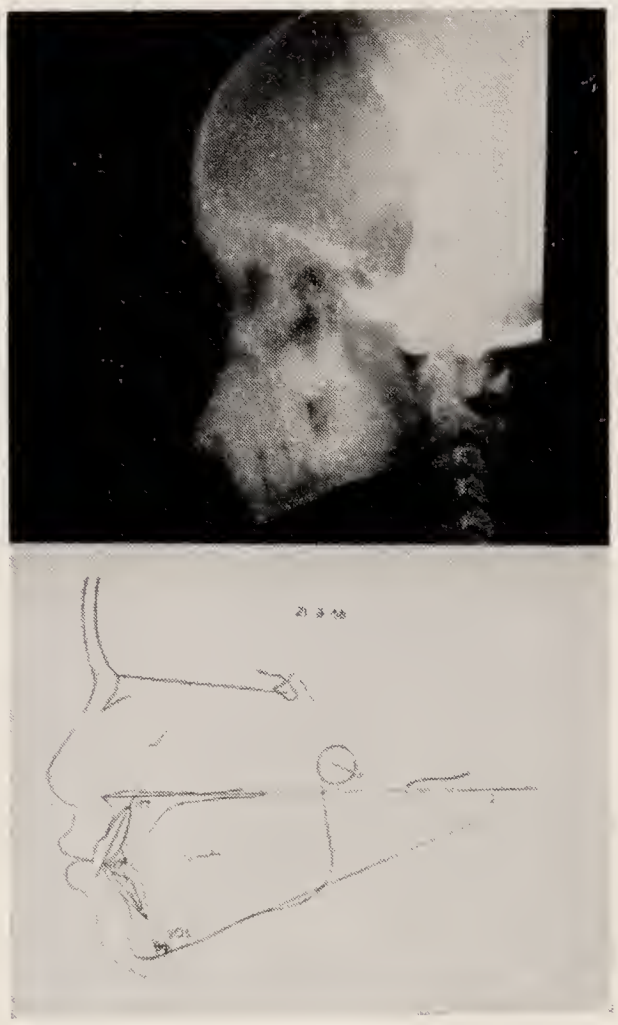

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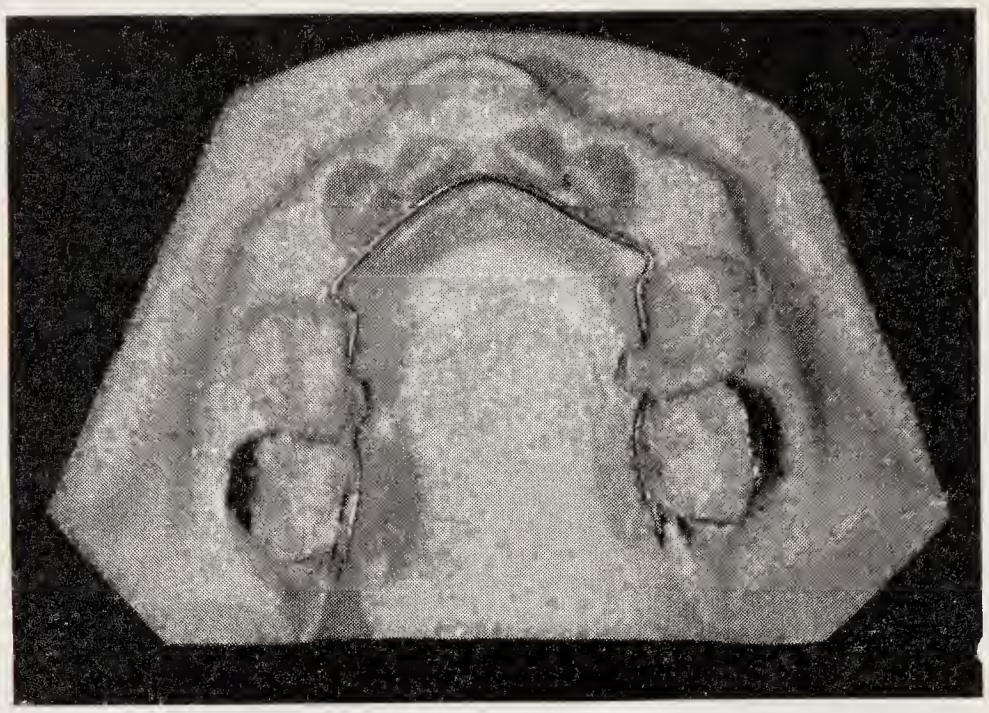
Fig. 1.—A, Photographs of patient prior to treatment; B, Models at start of treatment; C, Lateral skull X-ray and traeing at start of treatment.

Given at the Manehester meeting held on April 17, 1959.



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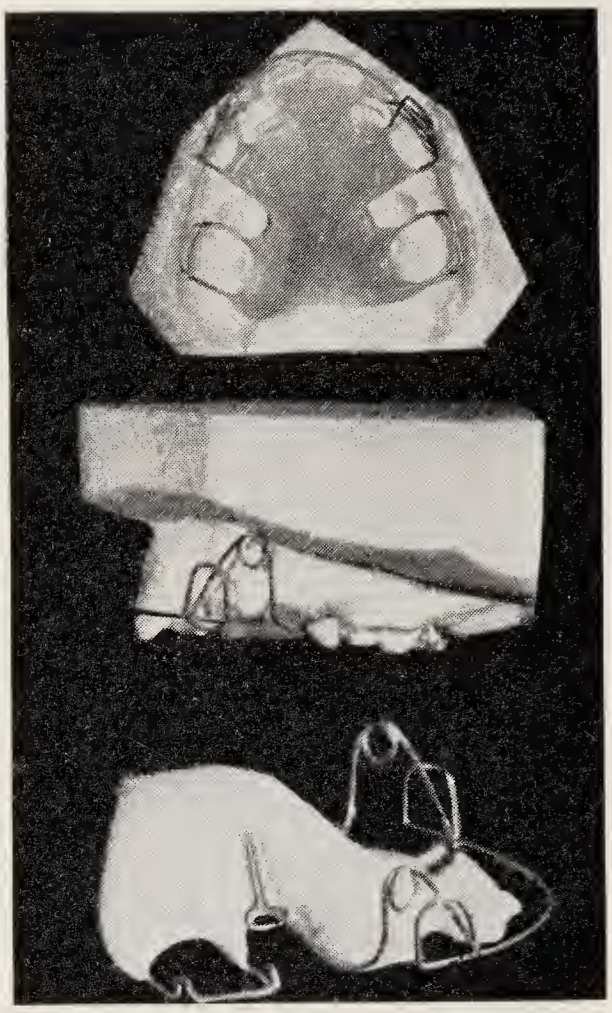
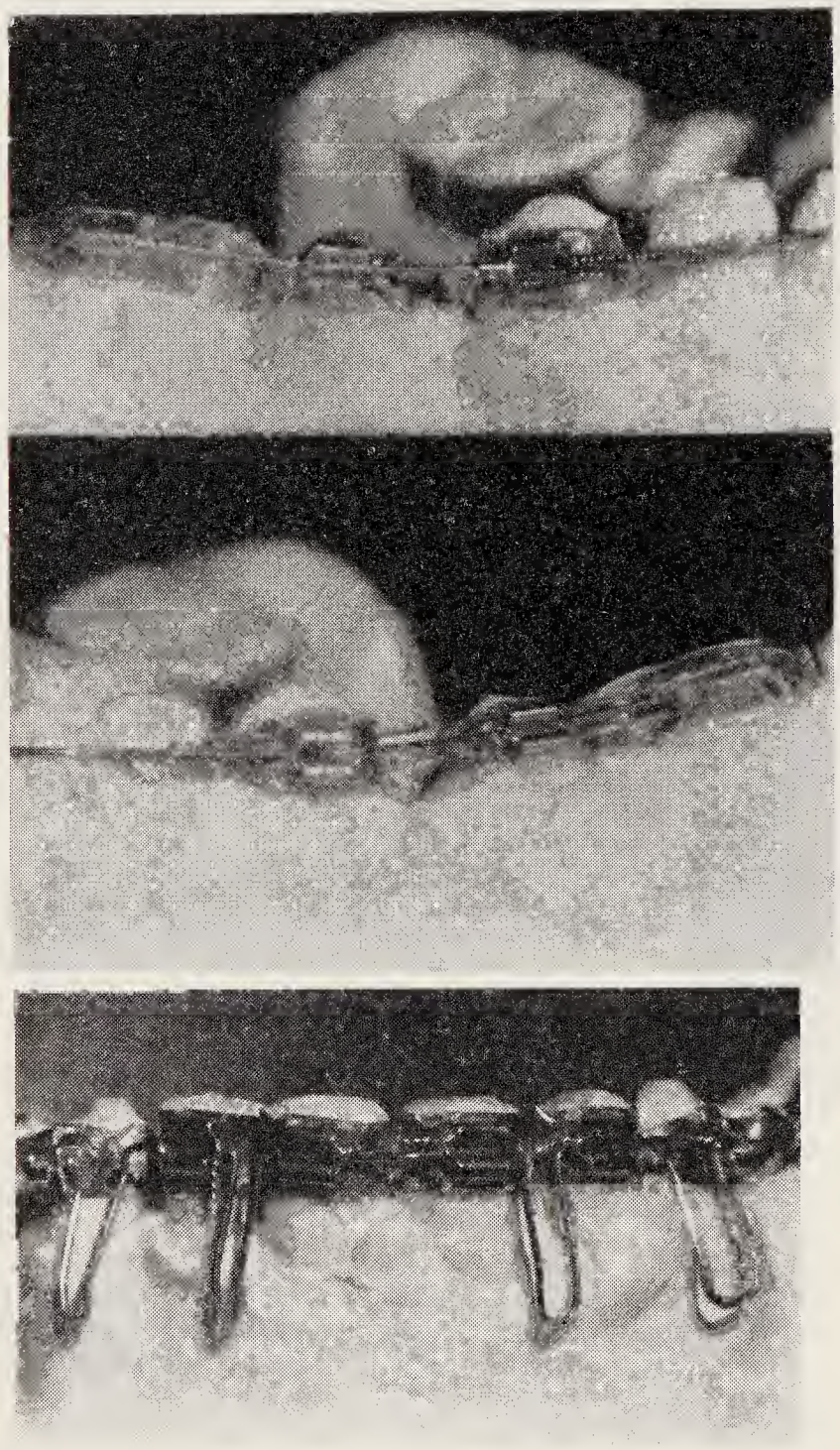


B

Fig. 2.—A, Simple 0·7 mm. lower lingual arch space maintainer; B, Removable upper space maintainer incorporating springs to retract $\underline{3|3}$ and move $\underline{5|5}$ buccally



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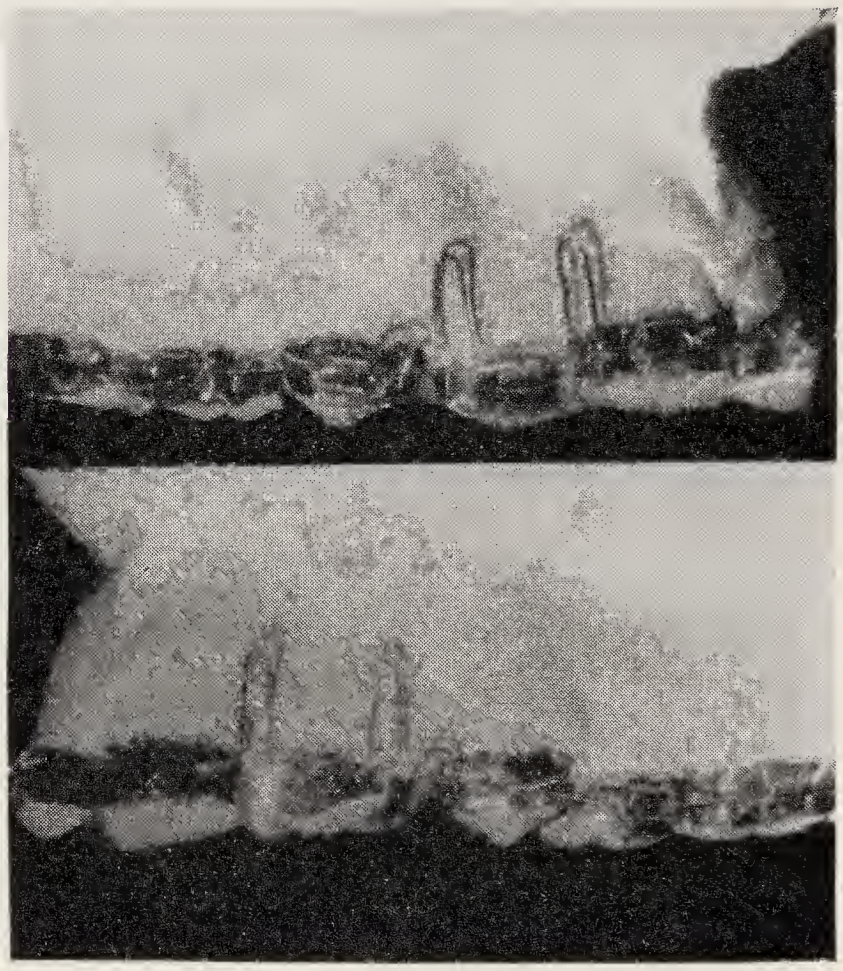


D

E

Fig. 3.—A, Lower multiband appliance to retract $\overline{3|}$ showing coil spring in passive position; B, Showing coil spring to $\overline{|3}$ activated by ligating back to distal of $\overline{|6}$; C, Lower multiband appliance showing archwire with third power bends to aline $\overline{21|12}$; D, E, Upper multiband appliance to aline $\overline{21|12}$—D in passive position and E activated by tying into brackets.

The upper centre line was over the right by 2 mm. His lips are incompetent; and he has a full everted type of lower lip" (*Fig.* 1 A).

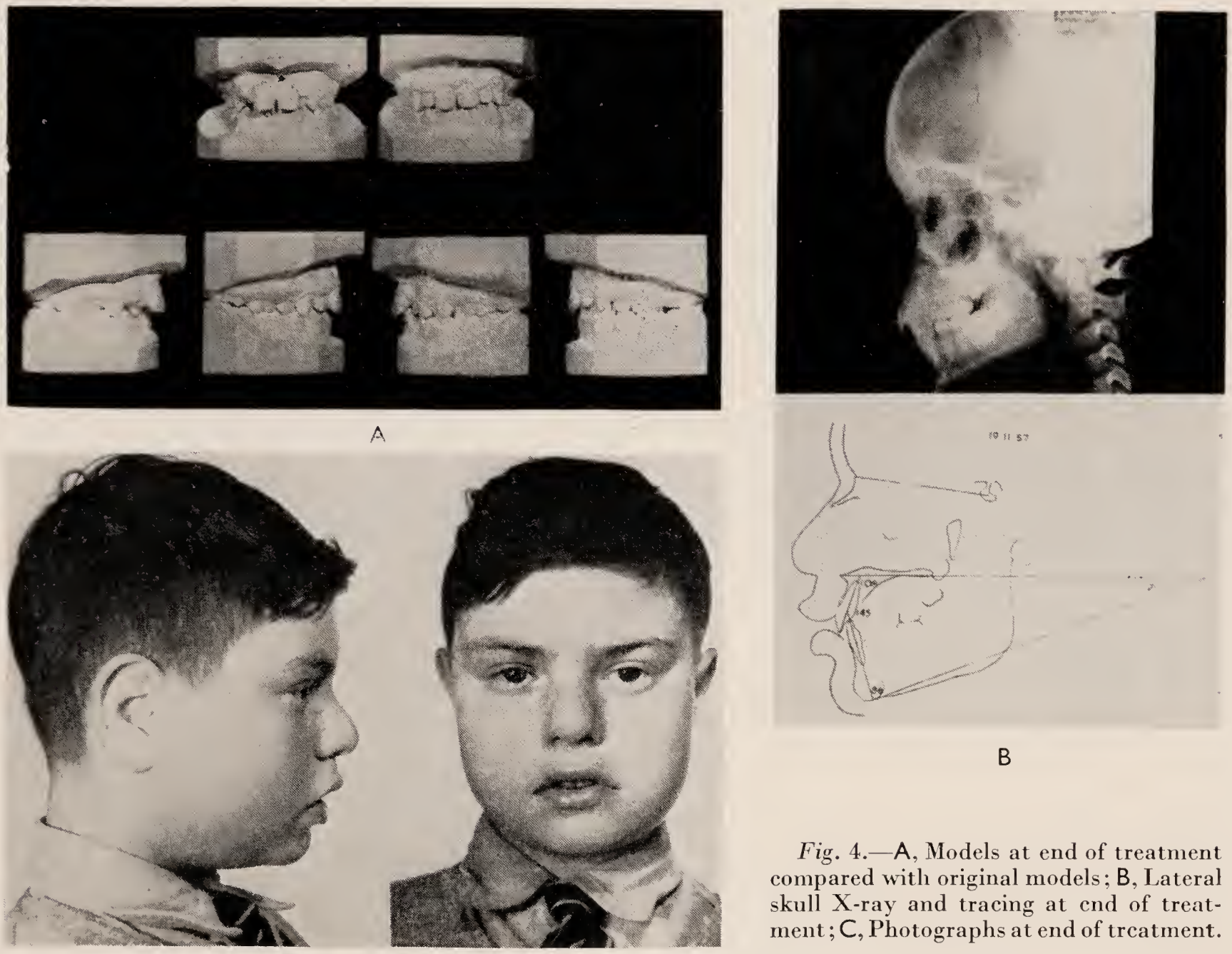
The lateral skull X-ray (*Fig.* 1 C) shows a bimaxillary proclination of incisors. It was felt that the axial inclination of the lower central incisors to the mandibular plane was not their true position of balance within the musculature, but was an artificial position due to the gross crowding in the lower incisor region forcing the lower central incisors out labially. It was felt that the stable position for the lower incisors was more likely to be that of the lower lateral incisors and that treatment should aim at that result. It can also be seen from the lateral skull X-ray that the upper apical base is short, as is indicated by the distal axial inclination of the upper second permanent molars, and that the upper third molars are developing vertically above the upper second molars. The unerupted upper canines are seen to be well forward in relation to the central incisors.

The treatment plan involved the extraction of all four first premolars, retraction of canines, retraction and alinement of the incisors.

TREATMENT.—In the lower arch, immediately following the extraction of the lower first premolars, a 0·7 mm. lower lingual arch, with bands on lower first permanent molars, was fitted (*Fig.* 2 A). This was a space maintainer to prevent the lower first molars from coming forward, and at the same time to allow the lower canines and incisors to move distally and start to aline under lip pressure: whilst waiting for the shedding of the lower second deciduous molars and eruption of the lower second premolars.

In the upper arch, following extraction of the upper first premolars, an upper removable appliance was fitted (*Fig.* 2 B). This was again a space maintainer, for use whilst awaiting the eruption of the upper canines. It incorporated buccal canine retractors to enable the appliance to be used to retract the canines when they erupted: the free ends of these retractors were tack welded to the labial bow so that they would not irritate the soft tissues. When the canines erupted they could be unwelded and used. The labial bow is of the reverse type, so that extra oral traction could be used, if necessary, to prevent the buccal segment coming forward during the retraction of the canines. On the palatal side of this appliance are springs to push the palatally placed second premolars bucally.

When the lower second premolars had erupted sufficiently, bands were cemented on these teeth and the lower canines and a 0·018 in. labial arch wire was ligated (*Fig.* 3 A, B). This had coil springs mesial to the canines tied back to the distal of the first molars; the arch wire was turned down distally. Thus first molars and second premolars were used as anchorage to retract the canines. When the lower canines were retracted distally, bands were placed on the lower incisors,



A

B

C

Fig. 4.—A, Models at end of treatment compared with original models; B, Lateral skull X-ray and tracing at end of treatment; C, Photographs at end of treatment.

and a 0·016 in. arch with third power bends (*Fig.* 3 C) was ligated to start their alinement.

In the meantime, in the upper arch the canines had erupted and were retracted and the second premolars had been moved out buccally. It was noted that the canines were somewhat rotated on eruption. During visits for adjustments to the appliances, bands had been made for the upper arch; they were now cemented and a 0·014 in. arch with third power bends, supported by Class II traction (*Fig.* 3 D, E) was ligated. This arch was not fully tied into the upper lateral incisors initially: the ligatures were gradually tightened over a period of four months. This arch moved the laterals labially and by reaction the central incisors were moved palatally. Class II traction supported the buccal segments and prevented their forward shift, and at the same time helped in the closing of the lower first premolar spaces.

When the upper and lower incisors were alined it was possible to insert 0·018 in. plain arches. To these arches Class II traction was applied in order to reduce the overjet and close the lower first premolar spaces; in the lower arch intra-traction was also used by means of rubber bands, to prevent proclination of the lower incisors due to frictional resistance of the arch in the channels of the brackets. Finally, 0·022 in. plain arches were inserted. Upper and lower bands were removed sixteen months after the start of treatment. Retainers were fitted and used for final closing of band spaces; the upper retainer was cut away behind the upper incisors and the labial bow activated. Retainers were worn for seven months. He was seen again at intervals after the retainer had been left out. *Fig.* 4 shows the models taken six months out of retention compared with the original models and post-treatment photographs and X-rays.

COMMENT

This case is of interest in that it illustrates the use of various types of appliances to achieve the necessary movements. Summarizing the treatment: removable and simple fixed appliances were fitted initially to undertake the first tooth movements, and whilst these were taking place bands were being made which were cemented when the time came to start the more complex tooth movements; thus, little or no time was wasted. Finally, bands were removed and retainers fitted, with which the final positioning of the teeth was accomplished. The total treatment time including retention was two years and one month.

Acknowledgements.—I would like to thank Mr. S. G. McCallin for permission to present this case; Mr. C. V. Hill for his advice and help in the practical treatment of the case; and finally Mr. E. Morgan, and his staff of the Photographic Department of the Eastman Dental Hospital, for the production of the slides.

DISCUSSION

The President thanked Mr. Broadway and added that it was a very good thing for them to deal with straightforward orthodontics at the beginning of their Conference in this way. They appreciated the way in which the cases had been presented.

Mr. W. J. Tulley congratulated Mr. Broadway on the presentation of the case. However, little had been said about soft tissue activity. If the position of the lower lateral incisors was stable, why had Mr. Broadway pulled them forward and why had he used Class II elastic traction? Why had he not used extra-oral traction?

Mr. Broadway said he was surprised, himself, that there were remaining lower first premolar spaces in this case. For the whole time he was using Class II traction he was also using intramaxillary traction in the lower arch, and that this was a little more powerful than the Class II traction. It was probably misleading to say that he was pulling forward the lower lateral incisors while retracting the lower centrals. It was a matter of retraction of the lower centrals and using the rest of the lower arch as an anchorage for doing that.

Mr. Tulley asked why the two centrals were forward.

Mr. Broadway said that perhaps the gross crowding in both arches might have the effect that the upper lateral incisors would erupt lingually to the lower central incisors which with the crowding already present in the lower arch resulted in the lower central incisors being further proclined.

Mr. P. H. Burke thanked Mr. Broadway and said he would like to refer to the remarks made about gingival recession of the mandibular incisors. He would like to know whether that aspect had been followed up and the effect when the central incisors were re-alined. In his experience of similar gingival recession associated with linguocclusion of a maxillary incisor and labial displacement of a mandibular incisor, the position remained static after alinement, and gradually, with the passive eruption of the other teeth, the gingival attachments became level.

Mr. Broadway said that in this particular case the gingival recession had not progressed. He was interested to hear about what happened with the eruption of other teeth. He had not noticed that, but certainly the position in his own particular case was no worse than when he had seen it originally.

Mr. D. F. Glass asked whether Mr. Broadway could give a rough indication of how many chairside hours he had devoted to the work.

Mr. Broadway said he could not give an estimate in chairside hours. Initially the patient had very simple appliances. He attended for treatment about every month or six weeks, and at each visit a few bands were made for him. The visits never lasted for longer than three-quarters of an hour, and if two bands were made at a visit, this was regarded as satisfactory. The total number of visits was not large and the total time spent on the case was not great.

Mr. Ritchie's question was that he noticed that lips were apart at the beginning and end of treatment and had Mr. Broadway tried the use of Elastoplast across the lips at night.

Mr. Broadway said he believed that the incompetent lips were an inherited characteristic which was unchangeable. The lips were incompetent; they were not potentially competent. Even at the end of treatment one would expect very little or no change in the lip incompetence. He did not believe the use of Elastoplast was justified. The mother had the same sort of lips and the child had inherited a family characteristic.

The President said he was sure it would be agreed that the case was still unfinished. It would be most interesting in, say, five years' time to see how it had progressed after further natural tooth movement had taken place. It would be well worth watching over the passage of years to observe the tendencies that occurred.

Mr. Poulter thanked Mr. Broadway. The case had been referred to, he believed, as a Skeletal II. Could the author enlarge upon the diagnosis? Regarding the musculature of the mother, had she had any orthodontic treatment or were her teeth in the same position? He agreed it would be interesting to see the case five years hence, after the orthodontic treatment had had sufficient time in which possibly to influence the musculature.

Mr. Broadway said he could give no information as to the mother's teeth: she was wearing full upper and lower dentures. When she had brought her child for treatment she had simply said that he had two rows of teeth, and examination of the mouth confirmed that this suggestion was quite reasonable. The inclination of the upper incisors to the maxillary plane was proclined from the mean. If the upper incisors were corrected to the mean and the lower incisors were similarly corrected, the lower incisors would be biting behind the uppers. That was called a Class II dental base relationship.

Mr. J. S. Beresford thanked Mr. Broadway for the paper. It was quite an event when someone came and read a paper to the B.S.S.O. Although so far as dental societies went they were as amiable as any, such a gesture called for courage and they were grateful to anybody who rendered such a service. He hoped the author would forgive him for asking two questions which sounded as if they came from the L.D.S. Finals. It might help if at the beginning of the Conference a number of definitions were made clear. How did the modern orthodontist define "nasal plane", and what points should one use on the X-ray plate? Also, what points should one use for the mandibular plane?

Mr. Broadway showed a slide and indicated the points thereon.

The President: Do you use the right or left or strike a medium?

Mr. Broadway: We strike a medium.

Mr. J. W. Softley asked what importance the author attached to cuspal interdigitation. The final slide relating to the paper showed that the occlusion of molars and the remaining premolars was still incorrect. Had an evaluation of the inclined plane action been made?

Mr. Broadway said he had not made an evaluation. He knew that on one side the occlusion was Class I and on the other side there was a slight Class II relationship. During the past eighteen months the occlusion had not changed at all.

The President said he felt that the discussion could go on for a long time. It was useful to have such cases discussed. He hoped there would be even more opportunities for them in the future to learn how various cases were treated. It was possible that some of them would treat a specific case in different ways, but it was instructive, for those with much experience as well as those with less, to be told how others set to work.

USES AND MODIFICATIONS OF THE JOHNSON TWIN WIRE ARCH

By **J. R. E. MILLS**, M.Sc., F.D.S., D.Orth. R.C.S.
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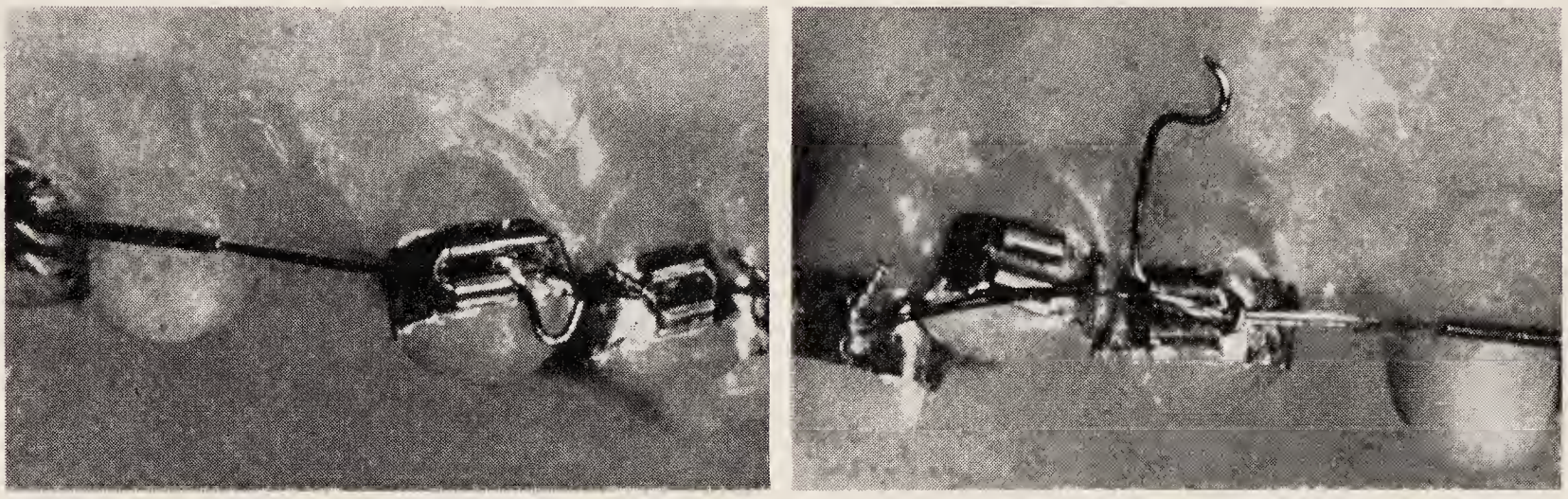
THE Johnson twin wire arch was first described by its originator in 1934 and subsequently in a number of papers including those in 1938 and 1942. Its description has been amplified by Madden (1948) and it was first introduced into Great Britain in a modified form by Townend (1947).

The appliance is, therefore, well known, and it is not proposed in this paper to describe the principles involved. I have been using the appliance for eleven years and I am proposing rather to describe those uses of the appliance which have stood the test of time.



A B

Fig. 1.—A, Individual traction hook on upper canine. B, Modified traction hook, for use where it is desired to reduce tilting of canine.

In making the twin arch, the first step is to construct molar bands on suitable posterior teeth and bands for the four incisors and, in some cases, the canines. An impression is taken with molar bands in place but without the incisor bands, and a model is cast. A piece of stainless steel tubing of internal diameter 0·9 mm. is soldered to the buccal face of the molar band in such a position that an extension of this tubing would lie level with the middle thirds of the incisor teeth. The easiest way to achieve this is to solder on a long piece of tubing to each band so that they meet in front of the central incisors in the manner described by Adams (1957). If the tubing is nicked with a file before soldering, the surplus may easily be broken off when the operation is complete. The twin wire arch consists of a central section of two wires 0·25 mm. in diameter, and two end sections made of tubing of 0·5 mm. internal and 0·9 mm. external diameter. These "end tubes" should be as long as possible; they should project slightly from the distal end of the buccal tubes on the molar bands and, at their anterior ends, they should finish about 4 mm. behind the most distal bracket on the anterior teeth. Having cut the tubes to the required lengths, a piece of 0·25-mm. wire is bent double and the end tubes are placed on the wire. They are adjusted against the model to the position which they will finally occupy, and the protruding ends of the twin wires are bent at an angle where they leave the end tubing. The tubes are then moved to the centre of the wire and that part in front of the sharp bends is kinked or "crimped" five or six times. The

Given at the Manchester meeting held on April 17, 1959.

end tubes are slid distally on to this crimped part of the wire until they come into contact with the sharp bends, by which time they should be in the correct position. The protruding ends of wire are cut off and any sharp ends are stoned. The twin arch is then fitted to the plaster model; it may be necessary to bend the anterior part of the end tubes lingually to follow the line of the arch, but the twin part should lie along the middle third of the incisors without bending the end tubes gingivally or occlusally. It is important that about 7 or 8 mm. of the end tube in front of the buccal tube should be quite straight, so that it may slide into the buccal tube.

The anterior part of the arch is ligated to the bands by means of "ripple brackets" as shown on the lateral incisor in *Fig.* 1 A. These are pressed from stainless steel tape 2·5 mm. wide by 0·2 mm. thick. They are welded to the band and their position should be such that when the teeth are finally alined the brackets will be level with each other. When welded to the band, the bracket forms two small tubes, one along its incisal edge and one on its gingival edge. The twin wire is attached to the band by means of a soft ligature wire of 0·3 mm. diameter. This is made into the shape of a hairpin with one arm longer than the other. The two arms are threaded one at a time through the small tubes of the ripple bracket and the free ends pulled tight and twisted tightly together. The twin wire is thus tied into the central gutter of the bracket but is free to move mesially and distally. The sharp end of the ligature wire is tucked away between the two teeth.

The above description applies in a typical case and there may be some variation to meet special requirements.

RETRACTION OF CANINES

In many cases, first premolars are extracted and the first step is to retract the upper canines. I normally prefer to do this by means of a removable appliance, which has better anchorage and reduces the likelihood of forward movement of the buccal segments. Occasionally, I use the twin wire for this purpose and, in this case, use the individual traction hook shown in *Fig.* 1 A. It is constructed of 0·5-mm. hard wire. A suitable piece is bent into a U shape so that the two arms will pass through the two tubes of the ripple bracket on a canine tooth. The twin arch is trapped between the U portion and the band itself, but it is important that it should be free to move mesially and distally and it may be necessary to bend the U portion slightly to permit this. The incisal end of the U is bent downwards and fashioned into a hook while the gingival end is cut off short. From this hook an intermaxillary elastic runs to the lower arch, either to a retraction plate or to a lower fixed appliance.

Fig. 2.—Occlusal view of upper arch, after retraction of $\underline{3|3}$, showing appliance for lingual movement of upper incisors.

An alternative type of traction hook is shown in *Fig.* 1 B. In this case, the more gingival arm of the U is bent upwards to form a hook which lies over the root of the tooth. Elastic traction from this hook will tend to move the root as well as the crown of the tooth and thus reduce tilting. The former type of hook can be used where the canine is mesially inclined and the latter type if it is vertical or distally inclined.

Having retracted the canines, they should be held back to prevent relapse while the incisor teeth are alined. This is best done by means of a Mershon lingual arch as shown in *Fig.* 5. This is attached to the molar bands and carries spurs which run mesial to the

canines. It does not fit closely behind the upper incisors since this would interfere with movement of these teeth. It also helps to control mesial drift of the buccal segments by preventing the mesio-lingual rotation of the upper first molars which accompanies such drift.

Alternatively, the canine may be tied back by means of a long ligature passing through its ripple bracket and around the distal end of the buccal tube as shown in *Fig.* 3 A.

The incisors may now be alined. This will involve one or more of several tooth movements which will be described separately but which may, in fact, be combined.

THE LINGUAL MOVEMENT OF UPPER INCISORS

The end tubes of the twin arch slide freely inside the buccal tubes while the anterior part is ligated to the incisor teeth as shown in *Fig.* 2. If a force is applied to the end tubes so as to move them distally into the buccal tubes, it will have the effect of moving the crowns of the upper incisors lingually. The most satisfactory way to do this is by means of an intermaxillary elastic to a hook at the anterior end of the end tube. A rigid hook fastened directly to the end tube is not recommended since it is difficult to position this and it has a tendency to project buccally or lingually. The hook may be constructed from a piece of 0·5-mm. brass wire which is soldered to a short length of tubing of 1·0 mm. internal diameter, as shown in *Fig.* 3 A. This tubing is then passed on to the end tubing and up to its anterior end. A stop is formed on the end tube immediately behind the hook to prevent the latter from slipping distally; this can be effected by grasping the end tube with a pair of pliers and squeezing it flat.

Alternatively, a modification of Trevor Johnson's "friction attachment" may be used, as shown in *Fig.* 3 B. A piece of 0·6-mm. wire is wound round a core of 0·8-mm. wire to form a very short coil of three or four complete turns. This may then be forced on to the end tube by rotating it gently as it is pushed forward to the anterior end. When it is in place, the free end of the wire is fashioned into a hook as shown. This device should grip the end tube tightly but, in practice, it is advisable to place a stop on the end tube just behind it.

A B

Fig. 3.—A, Hook, soldered to tubing, for intermaxillary traction. B, "Friction lock" hook for intermaxillary traction.

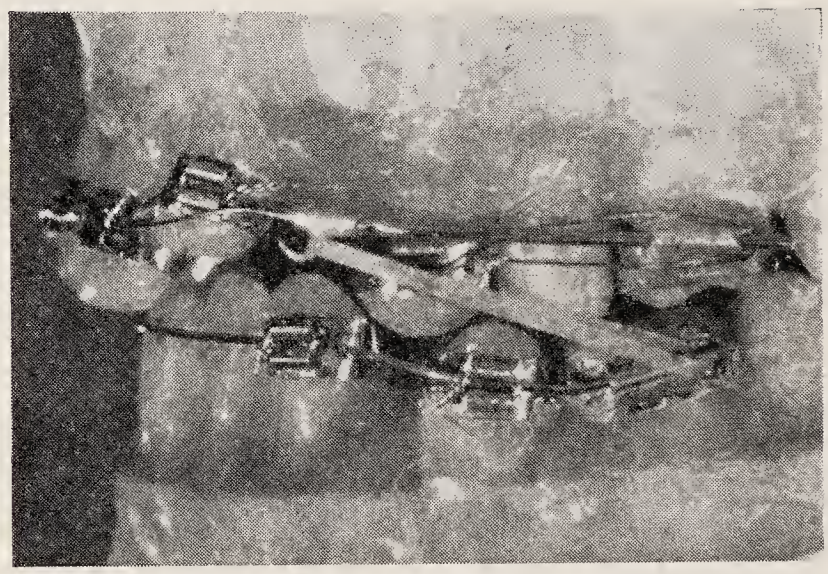


Fig. 4.—Intermaxillary traction for lingual movement of upper incisors and simultaneous mesial movement of lower buccal segment.

Having fixed the hooks on to the twin arch, it is inserted in the mouth. The patient wears intermaxillary elasties as shown in *Fig.* 4, and it is sufficient if these are worn at night only. The other end of the elastie band may go either to the type of fixed applianee shown in *Fig.* 4, to a lower traction plate, or to a lower lingual arch. The reciprocal effect would be to move the lower arch forward; as four upper incisors are being moved against the whole lower arch this is not usually serious.

One sometimes encounters a case where a canine is retracted to its desired position but there is residual spacing behind it. In this case it is desired to move the upper incisors lingually and the posterior teeth mesially. Intramaxillary traction is employed and the applianee previously described may be used with the elastie band running behind the protruding end of the end tubing instead of to the lower arch. Alternatively, the technique shown in *Fig.* 5 may be used.

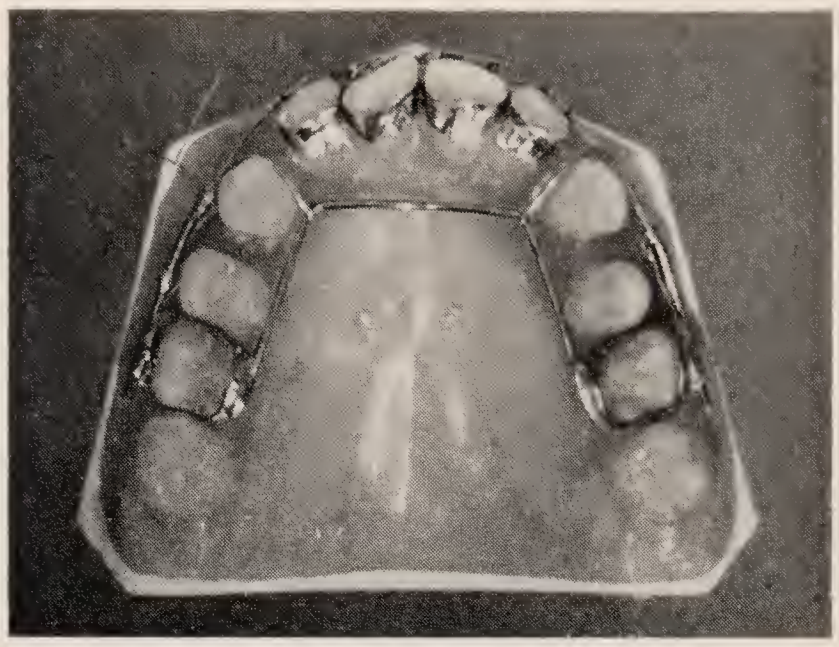
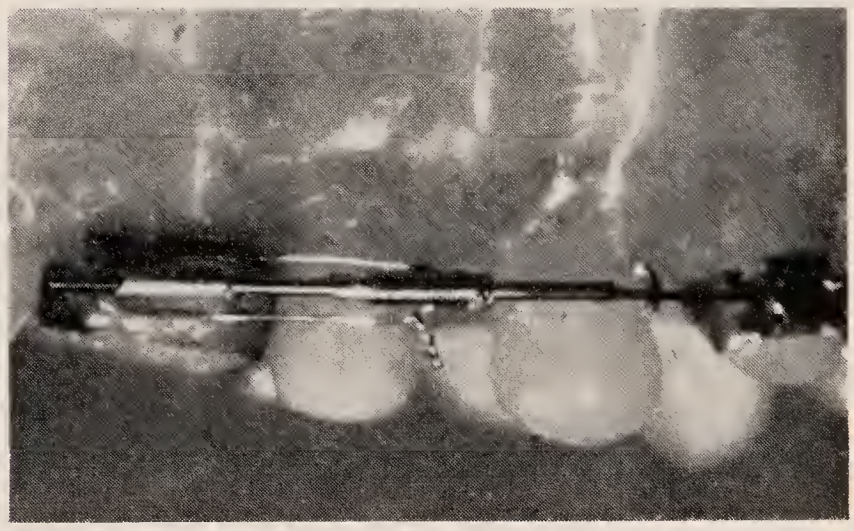


Fig. 5.—Appliance using coil springs for lingual movement of upper incisors by intramaxillary traction.

Fig. 6 A. The end of the ligature is passed round the protruding end of the end tube and pulled tightly so as to compress the coil spring. The two ends are then twisted together and cut off as shown in *Fig.* 6 B. The coil spring

A



B

Fig. 6.—A, Showing how the coil spring is "tied back" against a stop on the end tube.
B, The coil spring finally "tied back".

The twin arch is standard with the end tubes as long as possible. Two pieces of coil spring, each about 7·0 mm. long, are placed on the anterior part of the arch. This coil spring is formed from 0·2-mm. wire round a 1·0-mm. core as described by Adams (1957). A stop is fashioned on each end tube about 5·0 mm. in front of the buccal tube. The coil springs are then moved backwards against these stops. The twin arch is inserted in the mouth and the coil spring is "tied back"; a long piece of ligature wire is wrapped twice round the end tube in front of the coil spring as shown in resents this compression and tends to return to its former position. This drives the stop distally and with it the end tube, and this moves the upper incisors lingually. Reciprocal action draws the ligature mesially and this pulls the first molar mesially.

Great care should be used when employing intra-maxillary traction since the buccal segments are usually more ready to come forward than are the incisors to move lingually.

As previously stated, the lower arch may usually be employed for anchorage since the resulting proclination of the lower incisors is

so slight as to be acceptable. If this is not the case some form of extra-oral traction is necessary. It is not easy to apply this to the twin arch owing to the flexibility of the anterior segment. The most satisfactory technique is that described by Bercu Fischer (1952) and shown in *Fig.* 7. A labial bow is constructed

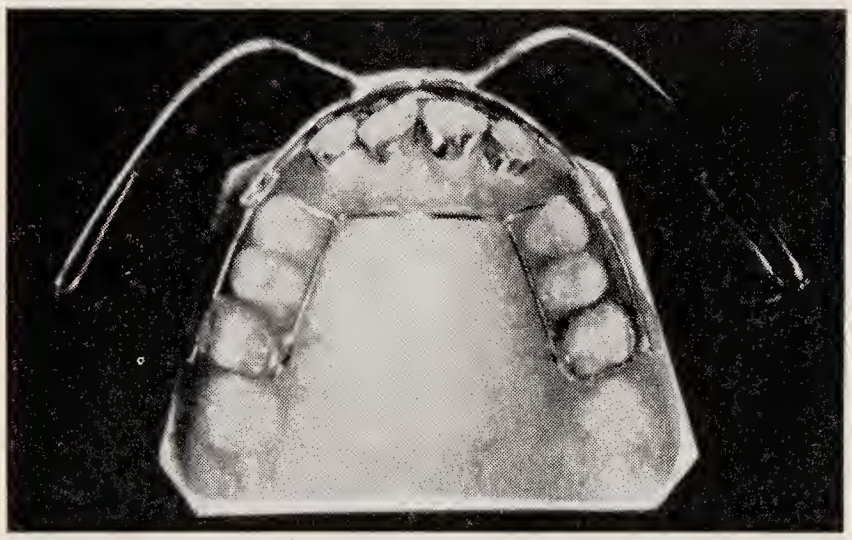
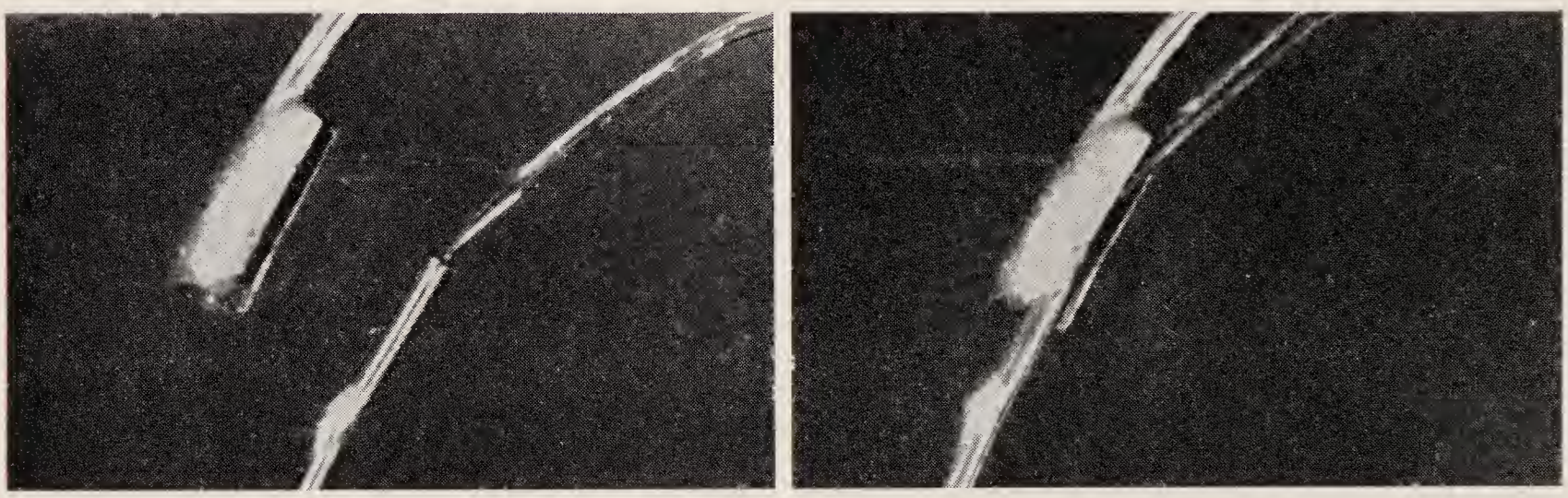


Fig. 7.—Attachment for extra-oral traction to the twin wire arch.

of 1·0-mm. wire to lie just labial to the twin wire with its ends overlapping the end tubes by about 4·0 mm. This is attached to a 1·25-mm. extra-oral bow by soldering opposite the two upper central incisors. A piece of stainless steel tubing about 4·0 mm. long and 1·0 mm. in internal diameter is soldered to the lingual side of each end of this labial bow. The inner side of this tube is then slit longitudinally with a carborundum disk as shown in *Fig.* 8 A. The twin arch is standard except that a stop is placed on the end tubing about 5·0 mm. from its anterior end and well in front of the buccal tube. The twin arch is inserted in the mouth. The extra-oral bow is attached at night by the patient; the slit tubing should be passed sideways over the twin portion and slid distally on to the thicker end tube until it comes into contact with the stop as shown in *Fig.* 8 B. This is done one side at a time by compressing the labial bow slightly, and the patients learn the technique surprisingly easily. The extra-oral bow is then attached by elastic bands to any type of extra-oral anchorage.

THE LABIAL MOVEMENT OF UPPER INCISORS

Individual incisors may be moved labially by merely ligating them to the arch. They will then take up a position in line with the remaining incisors. This technique may be used to move a single incisor over the bite provided that the overbite is only slight. If the overbite is deep, this method will be traumatic unless a lower bite plate is inserted. It would usually be more convenient to use a different type of appliance.



A B

Fig. 8.—Showing how the extra-oral bow is attached to the end tube of the twin arch.

All four incisors may be moved labially by means of a twin arch and this apparatus is particularly useful when there is a minimal overbite. It is, again, not very satisfactory if there is a deep overbite. The twin arch is constructed in the usual fashion but a stop is formed at the extreme anterior end of the end tube. A piece of coil spring 1·0 mm. in internal diameter is placed on the end tube so that it is slightly compressed by the buccal tube when the appliance is inserted. This is shown in

Figs. 9 and 10. The effect of this coil spring is to move the molars distally and reciprocally to move the twin arch and with it the anterior teeth labially. If the distal movement of the molars is undesirable, it may be minimized by the fitting of a lingual arch.

This is particularly useful where the four incisors are inside the bite and overbite is mini-

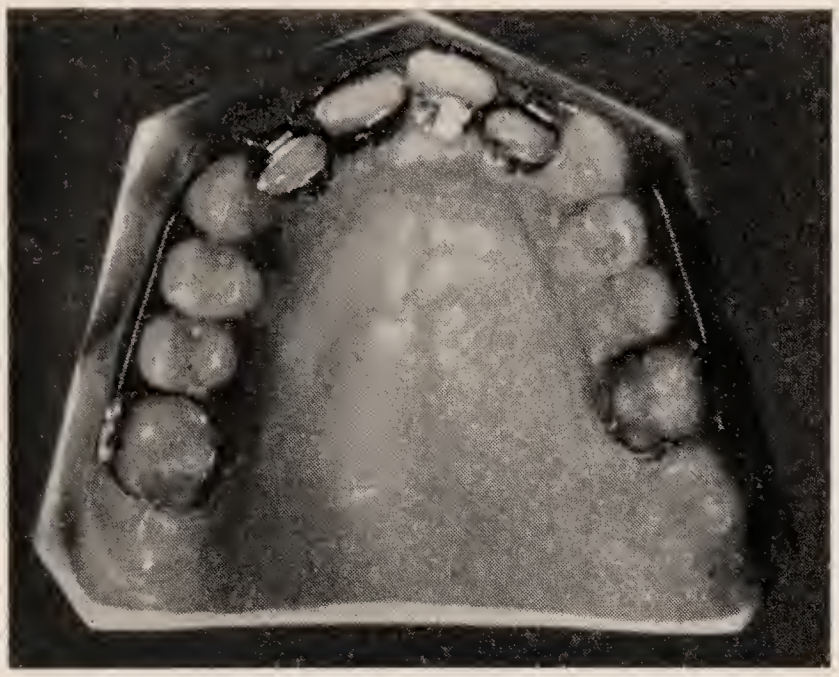


Fig. 9.—Appliance for the labial movement of upper incisors.

mal. If such teeth are moved labially, there is a strong tendency for the overbite to disappear completely with subsequent relapse. In this case, the buccal tubes on the molar bands should be so positioned that they slope downwards towards their anterior ends as shown in *Fig.* 10. When the twin arch is inserted, the anterior part of it, instead of lying along the channels of the ripple brackets, lies about level with the incisal edges of the teeth as shown in *Fig.* 11 A. When the arch is ligated to the teeth, it tends to return to its original position, thus moving the teeth in an incisal direction (*Fig.* 11 B). This counteracts the tendency for the overbite to reduce and enables one to maintain a small existing overbite. The same technique may, of course, be used in an effort to reduce an open bite, although the result is seldom stable.

INCISAL MOVEMENT OF INDIVIDUAL TEETH

A central incisor or a canine which has been surgically exposed will usually move downwards towards the arch without assistance.

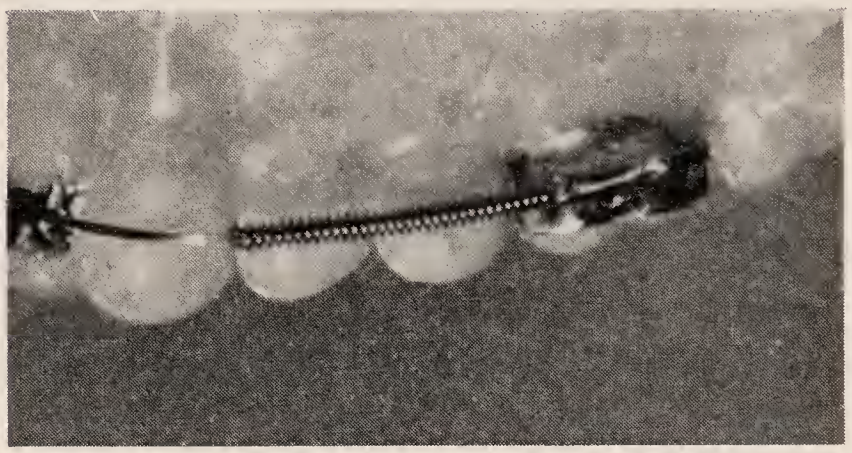


Fig. 10.—Coil spring for labial movement of upper incisors. The buccal tube slopes downwards at its anterior end.

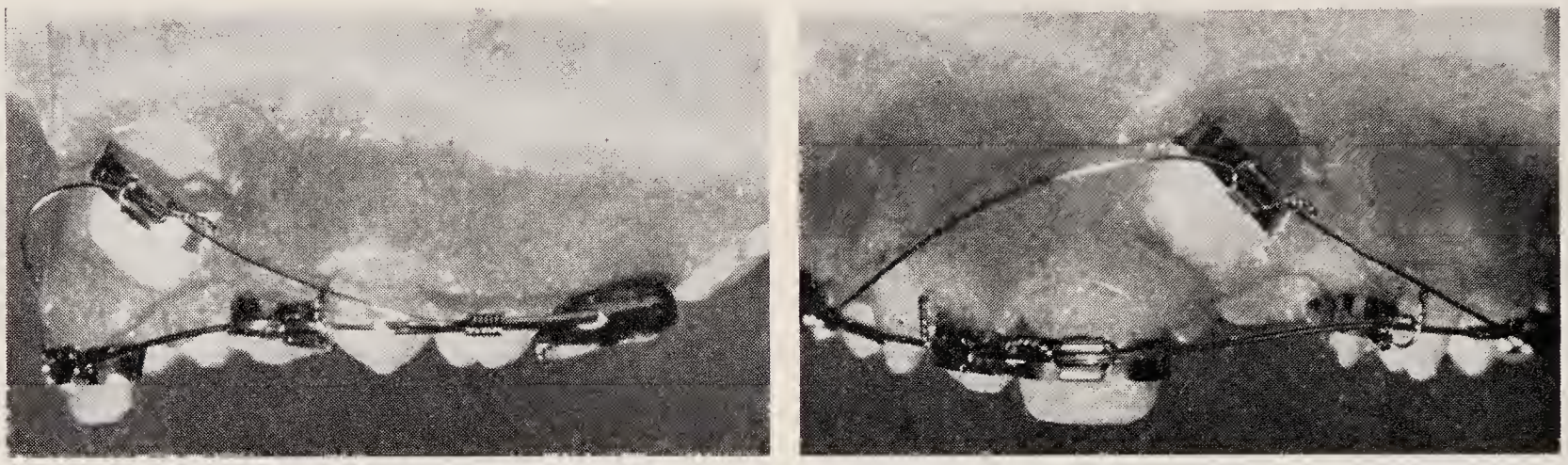
A B

Fig. 11.—A, Passive position of twin arch intended for incisal movement of upper incisors. B, The same activated by ligating to the incisors.

Occasionally, this does not occur and appliance therapy becomes necessary.

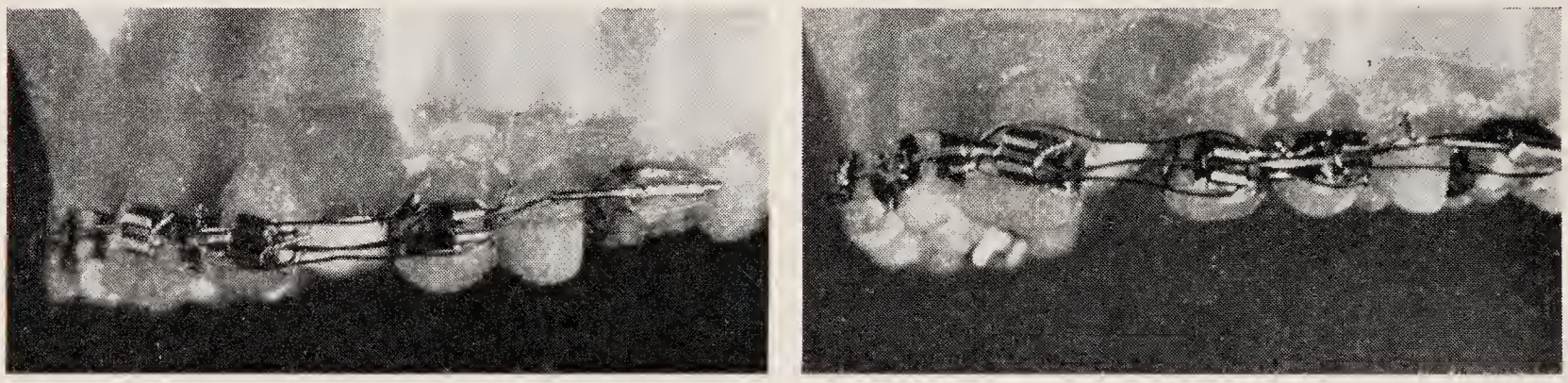
If the tooth is only slightly displaced in the occlusal plane, it may be brought down by ligating only one of the twin wires into the bracket as shown on the upper left lateral incisor in *Fig.* 4. If it is displaced some distance, an auxiliary arch is necessary. This is made from 0·35-mm. hard wire. It is slightly shorter than the twin arch and at each end it is wound into a short coil of six or seven turns and 1·0 mm. internal diameter. These coils lie over the end tubes and can slide freely along them, as shown

in *Fig.* 12 A. The main arch is ligated to the incisors and the auxiliary arch to the bracket on a band on the displaced incisor or canine, as shown in *Fig.* 12 B. This band may be cemented to the tooth at the time of exposure under an anæsthetic and can conveniently be made on a corresponding tooth on the opposite side. The arch exerts a gentle force on the displaced tooth, tending to move it down towards the occlusal plane. As this movement takes place, the auxiliary arch may be ligated to the remaining incisors, commencing with those furthest from the teeth to be moved, thus maintaining a gentle force on the displaced tooth. When the tooth is nearly in line, the auxiliary arch is discarded and the main twin arch ligated to it.



A B

Fig. 12.—A, Side view of auxiliary arch intended for incisal movement of upper incisor. B, Anterior view of the same appliance.



A B

Fig. 13.—A, Appliance for distal movement of $\underline{|2}$. B, Following retraction of $\underline{|2}$, the spring is transferred to $\underline{|1}$.

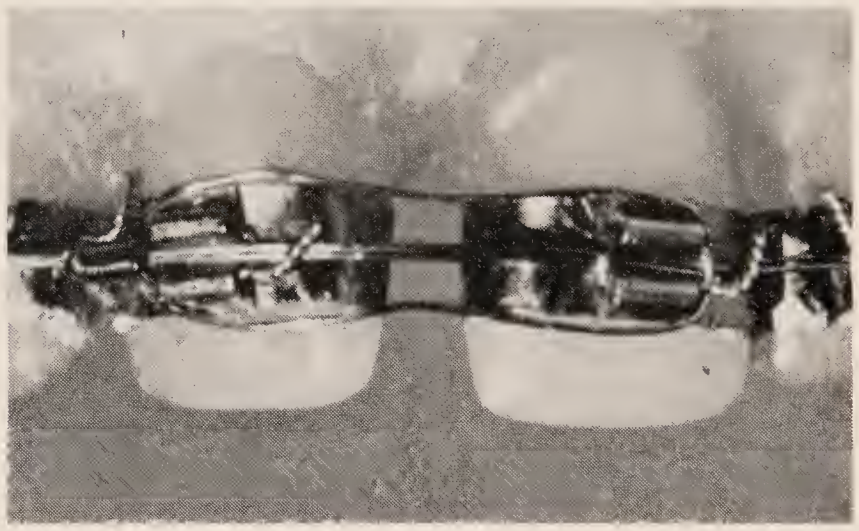
THE MESIO-DISTAL MOVEMENT OF ANTERIOR TEETH

Individual anterior teeth may be moved mesially or distally along the arch using lengths of coil spring about 4·0 mm. in length. This spring is made from 0·15-mm. wire wound on a 0·5-mm. core.

An example of this technique is shown in *Fig.* 13. In this case the upper centre is displaced to the right and it is desired to correct it. The left first premolar has been extracted and the canine retracted by any of the methods previously described. It is retained in position by a ligature through the bracket and tied back. It is advisable that a lingual arch should be fitted to stabilize the buccal segments and prevent their forward movement. This may carry a spur mesial to the canine to further stabilize this tooth. A 4·0 mm. length of coil spring is placed on the arch mesial to the lateral incisor as shown in *Fig.* 13 A. This may be put on before the twin wire arch is made or with a little ingenuity may be threaded on to the arch after it is complete; it will not pass over the end tubes. A ligature is tied back from this coil spring round the distal of the canine bracket as shown. The tooth will move until the coil spring is passive, when the ligature is

replaced and the spring once again compressed. The reciprocal action is the forward movement of the canine, but this is prevented, since the lateral incisor is pitted against the whole of both upper buccal segments. When the lateral has been fully retracted, it is tied back and the coil spring moved to a position mesial to the upper central incisor as shown in *Fig.* 13 B. The central is moved across in the same way and the process may be continued for each tooth in turn.

A



B

C

Fig. 14.—A, Appliance for reciprocal distal movement of 1|1. B, Appliance to close median diastema. C, Modification suitable for closing small diastema.

Two incisor teeth which are crowded together and imbricated may be moved apart quite simply by placing a piece of coil spring of the appropriate length on the arch between the two teeth as shown in *Fig.* 14 A. A median diastema may be closed by using a 4·0-mm. length of coil spring which is placed laterally to one of the incisors and tied back round the distal part of the bracket on the opposing central incisors (*Fig.* 14 B). A small median diastema may, in fact, be closed merely by passing a ligature as a figure of eight round the distal of both brackets as shown in *Fig.* 14 C. This ligature should be tightened until the patient is aware of some tightness, but not until pain is produced.

ROTATION OF INCISOR TEETH

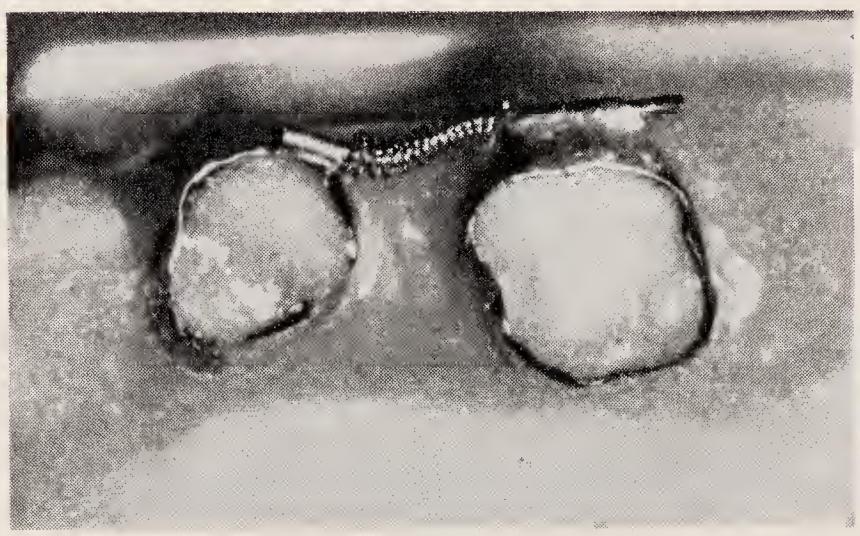
The twin arch is an excellent appliance for the rotation of incisor teeth. The length of the bracket is such as to make mesial and distal eyelets unnecessary. If a tooth is grossly rotated, the ligature should only be tightened sufficiently to deform the arch slightly as shown on the upper right lateral incisor in *Fig.* 15. If it is tied right down into the bracket, it will kink the wire and probably loosen the tooth.

Fig. 15.—Modifications for rotation of upper incisors.

The twin arch will readily rotate a tooth into the line of the labial segment, but it will not produce that degree of over-rotation which is so desirable to prevent relapse. A slight degree

of over-rotation may be achieved by "off-setting" the bracket—that is by placing a small bracket as far distal on a disto-lingually rotated tooth as possible; this is shown on the upper left lateral incisor in *Fig.* 15. Further over-rotation may be achieved if, in addition to this, a protuberance is placed on the opposite end of the labial surface of the band. This is made from stainless steel tape 2·5 mm. wide and 0·25 mm. thick. It may be welded at both ends with thc centre part standing away from the bracket as shown on the upper right central incisor. A shallow slit is cut with a carborundum disk in the most labial part of the bracket to accommodate the twin wires. Alternatively, the tape may be welded only at the end nearcst to the ripple bracket as shown on the upper left central incisor. The other end of the tape is then curved out from the tooth and groovcd to take the twin wire. This later method has the slight advantage that it can be adjusted during use.

Any rotation of teeth and, indeed, most alinement of anterior teeth has a tendency to produce a slight overjet. This is because rotation normally takes place about the centre of the tooth, whereas the most lingual part of the tooth is in contact with the lower incisors. Because of this, lingual pressure should always be held on the incisor teeth in using the twin arch, either with intramaxillary, intermaxillary, or extra-oral traction.



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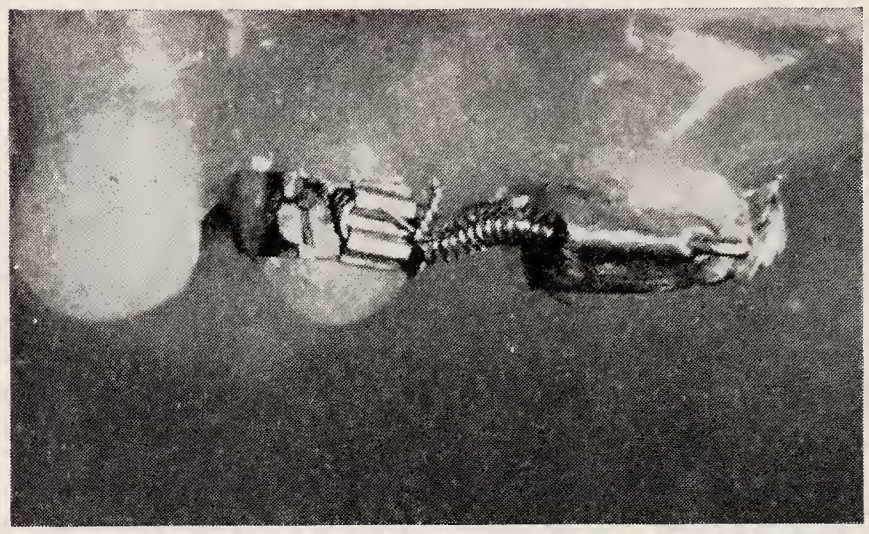

B

C

Fig. 16.—A, Occlusal view of the sectional twin arch, for reciprocal movement of $\underline{|46}$. B, Buccal view of the same appliance. C, The component parts of the sectional twin arch.

FINAL ALINEMENT OF ANTERIOR TEETH

In a majority of cases it is desirable finally to aline the teeth by the use of a solid wire. A 0·45-mm. wire, preferably high tensile, is threaded through end tubes and slightly crimped inside them as for the twin wire. This must then be preformed carefully to fit the arch since, unlike the twin wire, it is capable of producing lateral expansion or contraction of the buccal segments. It will position the incisor tooth exactly and it is possible with this to inset the lateral incisors slightly and carry out similar final movements.

MOVEMENT OF POSTERIOR TEETH

Mesial movement of upper cheek teeth to close residual spaces has already been described. Using the twin arch there is a strong tendency

for the upper posterior teeth to tilt mesially and for this reason light forees should be used.

Methods of moving the bueeal segments distally have been deseribed by Johnson (1934), Madden (1948), and Townend (1947). These methods undoubtedly work in seieeted eases, but I personally prefer to use other applianees to aehieve this tooth movement.

THE SECTIONAL TWIN ARCH

This is an extreme modifieation of the twin areh whieh is very useful in a single instanee. This is where, following the loss of a deeiduous molar, the first molar has drifted and rotated mesially and the first premolar distally, as shown in *Fig.* 16 A. Slight spaeing exists between the eanine and the first premolar with impaetion of the seeond premolar. To re-open this spaee, bands are made for the first molar and the first premolar only. A rather short bueeal tube is fixed on the first molar and a ripple braeket on the premolar. Ideally, both of these should be parallel to the true bueeal surfaee of the tooth, but it is neeessary to be able to insert a short pieee of end tubing into the bueeal tube when the appliance is in the mouth. A short pieee of end tubing—no longer than the bueeal tube on the molar—is taken and a pieee of 0·25-mm. wire doubled and the two ends threaded through the end tubing almost as far as possible. The protruding ends are erimped and the double end is drawn baek to produee a single-ended twin areh about 12–15 mm. in length. The final artiele is shown in *Fig.* 16 C and looks not unlike the deviee sometimes used to thread needles. A pieee of eoil spring 1 mm. in internal diameter is threaded over the whole seetional areh. The end tube is plaeed inside the bueeal tube in the mouth, the eoil spring eompressed, and the anterior end ligated to the ripple bracket as shown in *Fig.* 16 B. In doing so, the ligature wire must pass between the two twin wires at the anterior end to prevent them slipping distally out of the ripple braeket. The effeet of the eoil spring is to push the bueeal surfaee of the two teeth apart, whieh re-opens the spaee and simultaneously rotates the tooth. The flexibility of the twin wire permits this rotation to take plaee.

THE LOWER ARCH

Again there is no doubt that the twin areh ean be used sueeessfully on the lower teeth. It is, however, liable to trauma from the oeclusion and it is also diffieult to make it follow the inereased eurve of von Spee whieh is often present. The present auther has eompletely abandoned its use in the lower areh, preferring to use a light 0·45-mm. round wire sueh as is shown in *Fig.* 4.

CONCLUSIONS

1. The twin wire areh eonstitutes a useful eompromise between the eomparative inaeeuraey of the removable applianees and the trauma and fatigue of fully banded teehniques.

2. It is most useful for earrying out those movements of the upper ineisor teeth whieh do not involve movement of their apiees.

3. It should be regarded as one weapon in our armamentarium and not as a universal appliance.

Acknowledgements.—I would like to aeknowledge the assistanee I have reeeived over many years from my eolleagues at Liverpool, Manehester, and the Eastman Dental Hospitals in showing me many of the modifieations I have deseribed. I would also like to thank Mr. D. T. Hartley for the loan of an aerylie model shown in *Fig.* 12, Professor Ballard for eneouragement and permission to publish the paper, Mr. Morgan and his staff for taking the photographs, and Miss J. Jeffery for seeretarial assistanee.

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DISCUSSION

The President thanked Mr. Mills for a valuable and practical paper on the twin-wire mechanism. Many of them would remember when thirteen years or so previously that mechanism became very popular and they used to read in the journals about elaborate and attractive attachments and wonder how they could obtain them. Twin wires had always appealed greatly to orthodontists in this country. The edgewise always had a mystique of its own; it had always had its high priests and apostolic succession! In this country many had been nervous about embarking on its use, but descriptions such as members had just heard enabled them more clearly to understand it. Perhaps some people had rushed in and used it a little too readily. It was a flexible and useful mechanism.

The buccal tubes described by Mr. Mills seemed to be short. He himself had used longer ones in order to steady the end tubes.

The President asked Mr. Mills whether, when he was using intermaxillary traction with retraction coil springs, he measured the relative forces and balanced them off.

Mr. Mills agreed that he used buccal tubes rather shorter than most people's. He used stainless steel tubing and personally found no difficulty with it. He thought that it was very desirable to use tubing which was perfectly round rather than a tube which has been constructed from tape. Mr. Mills agreed that it was desirable to measure the forces used, although he did not always do it.

The President called on Mr. Hartley to open the discussion.

Mr. Hartley said that it gave him great pleasure to open the discussion on the extremely useful and practical paper read by his friend and former colleague.

The deplorable misuse by American confrères of the word "philosophy" found, he trusted, no support in this country. British orthodontists remained sturdily independent in preferring to subordinate the appliance to the malocclusion, rather than attempting to fit all their patients into any single system of treatment.

Mr. Mills's approach to the twin-wire arch as a tooth-moving mechanism was surely the right one, and he had covered with admirable clarity and detail virtually all the possible tooth movements of which this appliance was capable. As these were essentially the result of the mechanical attributes of the appliance it was unlikely that there would be any major differences between operators in their methods of using it. With the exception of the special modifications, notably Mr. Mills's sectional twin arch and the auxiliary arch for a surgically exposed tooth, he found that his personal use of the twin-wire appliance corresponded so closely to Mr. Mills's that they differed only on small points of technique, one or two of which he would illustrate.

The preformed attachments which he preferred were: the twin tie channels to be made in two widths (3 mm. and 2 mm.) to cover the needs of central and lateral incisors. Their great advantage lay in the flange which projected at each end for spot-welding to the band. This made a special knife-edged electrode or welding jig for the centre channel unnecessary. The flanged buccal tube was, in his opinion, a considerable advance on the soldered type described. It was welded to the molar band at the chairside, using the following technique: the buccal surface of the molar band was marked with a small file held closely against the canine and premolars. This indicated the position for correct tangenital attachment of the tube on the curved surface of the band. The band was removed and the buccal tube attached by one light weld on the gingival portion of the flange. The band was re-seated on the tooth and a 7-cm. length of end-tubing used as a lever to twist the buccal tube upwards or downwards around the single weld point until the tubing was at the required level anteriorly, when the flanges were firmly welded. The other side of the mouth was dealt with similarly, correct alinement being obtained by setting the second guide-tube at the same level anteriorly as the first.

This direct technique eliminated the need for taking an impression, casting a working model, soldering and polishing; it guaranteed correct alinement of the buccal tubes; and it enabled him to cement the bands and complete the appliance at one appointment if he so wished.

Mr. Mills had referred to the difficulty of keeping soldered intermaxillary hooks in the vertical plane when drawing the twin arch to length. This seemed to be a common problem, but it could be readily solved by grasping the projecting right-angled ends of the twin wires on the affected side and twisting the end-tube round until the hook was in correct alinement. This had been described by Dolce in 1943.

He was a little surprised to hear the distal movement of posterior teeth dismissed so summarily. He had always thought it rather surprising that using the Johnson technique in a Class II case the upper incisors were fully retracted first, leading to crowding of the canines and premolars. Coil springs were then added to move the molars distally, when the premolars followed in most cases. However, if one started by moving the molars back the premolars did not follow and treatment was more complicated. He wondered if Mr. Mills would enlarge on his experience of this?

His second question concerned overbite reduction. He gathered from the literature that this readily occurred during twin-wire technique, but said that this had not been his experience. He said that Madden mentioned that the extraction of premolars made bite-opening very difficult, so perhaps that was the source of his trouble. Could Mr. Mills comment on this point?

Throughout the paper the attention of the members had been drawn to the outstanding springiness of the twin-wire appliance. The extent of this might not always be realized. It was instructive to compare it with a single round wire appliance of the same overall size, similar to that used for final alinement of incisors.

Assuming identical physical properties (although this was not strictly true because of the extra work-hardening received by the finer wire in manufacture), a single 0·25-mm. wire was sixteen times as springy as a 0·5-mm. wire (springiness varies inversely with the fourth power of the diameter). On the other hand, it had only one quarter of the strength (strength varies directly with cross-sectional area). The twin-wire appliance was thus half as strong, but eight times as springy, as the single 0·5-mm. arch.

Nevertheless the long-range automatic action of this appliance was not without its dangers, as the President had just pointed out. In 1953 Moyers and co-workers had reported that during animal experimentation it was found easier to produce root resorption with the twin wire than with any other appliance tested, including the edgewise. He said that there was still no substitute for

the orthodontic skill and clinical experience which had so obviously formed the background to Mr. Mills's excellent paper.

Mr. Mills thanked Mr. Hartley for his remarks. The preformed anterior brackets were, of course, rather expensive. He personally had not found the twin arch very satisfactory for the distal movement of molar teeth. It was difficult to apply extra-oral traction to the appliance. He had attempted to show those tooth movements for which he personally found the twin arch satisfactory, but he realized that others used it for distal movement of the molars.

In the case of a deep overbite, his normal procedure was to retract the canines with a removable appliance which carried a bite plane to reduce the overbite. The twin arch would then be able to move them lingually. If this was not successful, then the incisors were pulled lingually in an effort to slide them up the lower incisors. It had been suggested that this might cause apical resorption, although personally he had not found it.

Mr. G. C. Dickson thanked Mr. Mills for an instructive paper. Regarding sectional twin arch, the slide which had been shown illustrated the premolar fairly well away from the molar. The loss of space was not gross. But it seemed that if the loss of space was at all gross there would be little room to accommodate a sectional arch and spring. Was there an arch to meet that problem?

Mr. Mills said that Mr. Dickson always spotted the weakest point. The sectional twin arch was only really useful where loss of space for the second premolar was moderate. It was particularly useful where there was spacing between the canine and first premolar.

Mr. J. W. Softley thanked Mr. Mills for the paper. He used a multiple arch with four 0·15-mm. wires in the end tubing, which provided a much gentler action than two 0·25-mm. wires, and was much more flexible than a twin arch. In the case of uppers one could use six 0·15-mm. wires in the end tube and tie them right down to much greater malocclusions than was possible with two 0·25-mm. wires.

Mr. Mills remarked that this was one of the many applications of the twin arch which Mr. Softley had shown him many years ago. He had occasionally used it where teeth were very irregular, but found that it was apt to become damaged owing to the thinness of the wires. In the lower arch, he preferred to use a single round arch for the reasons stated above.

Mr. A. J. Walpole Day said there was one question which ought to be asked, more especially for the benefit of newer members. Mr. Mills had shown them very clearly how they could use the arch for distal movement, mesial movement, rotation and occlusive movement, but he had not enlarged on the other movement: that of altering the inclination of roots of teeth where for example there were two incisors with the apices close together and it was desired to get them apart.

Mr. Mills said that he did not find the twin arch very satisfactory for apical movement, but would prefer to use a thicker appliance for this purpose.

Mr. H. G. Watkin said that his main purpose in speaking was to congratulate Mr. Mills and to say how much he had enjoyed listening to the paper, which was very well illustrated. It was, of course, necessary to have the right pliers in dealing with a particular appliance. He personally preferred the pin-and-tube appliance.

Mr. Mills said that Mr. Watkin had taught him the pin and tube appliance many years ago, and he had used it ever since. Unlike the twin arch, it would produce apical movement. It was rather open to abuse, but, if used properly, had a very definite place in our armamentarium. He was opposed to any appliance being regarded as a universal appliance.

Mr. J. H. Gardiner said he would like to add his congratulations to those already received by Mr. Mills for his clear paper. In the case of more violent patients, had he found that the buccal tubes pulled away from the band when they were purely soldered to the band?

Mr. Mills agreed that people had encountered difficulty in soldering stainless steel. The technique was difficult but, once mastered, there was little trouble. Many people welded tape around the tube to reinforce the soldered joint.

Mr. H. G. Watkin said that he used to solder tubes to bands but the join never remained. In his opinion soldering was no good. He welded a semicircular tube with tabs on to a band and then used a No. 2 drill to make the circle of the tube complete. The join never became unwelded and the teeth were never harmed. The drill helped to make a nice fit and the wire slipped in comfortably and without trouble.

The President said the Secretary was collecting material for demonstrations at next year's meeting and the device just referred to might be very useful in that connexion.

Mr. D. T. Hartley said that the occasional failure of soldered joints in the mouth was probably the result of stress corrosion at the interface of solder and stainless steel. While poor technique might well be partially responsible there were probably other factors involved, for example, the composition of the solder.

Mr. Norman Gray thanked Mr. Mills for his paper, which was packed with valuable information for those who use the twin-arch technique. The more one uses the twin arch, the more one will appreciate the points which Mr. Mills had raised. It was rather difficult to criticize the paper because it was so accurate. Mr. Gray would like to ask Mr. Mills one question about rotated upper incisors. Had he ever used just an anterior section of twin-wire arch using banded incisors alone, sometimes even in conjunction with an over-riding removable appliance?

Mr. Mills said he had not tried that. He had been hoping the discussion would bring forward suggestions from other people, and that was one he would certainly try out.

Mr. J. Angelman congratulated the author and said he was in the happy position of seeing some of his work and some of its excellent results. It might be opportune to remind Mr. Mills of a modification which had not been mentioned: the intermaxillary hooks were extended and small tubes were added to them on which there were U-attachments which were slid on and off by the child, and fixed on by elastics to a headgear. That modification was very simple to use; but he did not think it a very good appliance for rotations. Certainly in his hands a fixed appliance was less efficacious when one came to think of rotations. The soldering of stainless steel was extremely difficult and welded attachments and buccal tubes were far more efficacious.

Mr. Mills said that Mr. Angelmann had inherited a lot of his former patients, and the device referred to was one which he had now discarded. He had described it fully in the DENTAL PRACTITIONER, 7, 208.

He would repeat that he found the soldering of stainless steel quite satisfactory once the technique was mastered. It was important to use a lot of flux and to heat the wire to red heat quickly and then to remove the

flame before the whole area became oxidized. He felt that many people were afraid of heating wire and blackened it without melting the solder.

Mr. F. K. Johnson complimented Mr. Mills upon the paper, and said the appliance had one or two disadvantages. First, it was not easy to keep it clean. When a patient was seen it was usually necessary to remove the remains of the last meal. Then there was difficulty in tucking away the ligatures. They sometimes got dislodged and caused ulceration. Was there any foolproof way of disposing of the ligatures in the twin arch?

Mr. Mills said that all fixed appliances were potentially dirty, as indeed were removable ones. It was possible to keep the appliance clean, and he felt that orthodontists were entitled to some co-operation from their patients. The ends of ligatures he tucked down under the twin wire with a plastic instrument. If they worked loose, the patient could protect the soft tissues by placing a small piece of cotton-wool over the sharp wire until he could attend for repairs.

The President said he felt the discussion had indicated how well the paper was received and enjoyed. He thanked all those who had contributed to the discussion, particularly Mr. Hartley for opening it, and again thanked Mr. Mills for a paper which all of them much appreciated.

REHABILITATION OF THE CHILD WITH CLEFT LIP AND PALATE

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It is not generally realized that 8 births per 1000 are congenitally deformed and that of these 8 per 1000 the commonest defect is club-foot (26 per cent), while the clefts of lip and palate amount to 17 per cent (Ivy, 1957).

The occurrence of clefts of lip and palate in this country is at least 1 in a 1000, which means that, annually, between 700 and 800 such children are born who will require specialized attention.

Throughout this paper the term "clefts" is used as a collective term to include all common clefts of lip, alveolus, hard palate, and soft palate, and covers a large variety of defects occurring at the junction of the processes which unite to form the face. These may conveniently be divided into common clefts and uncommon clefts; it is not the purpose of this paper to consider any of the uncommon clefts.

Common clefts have been classified in many ways by the embryologists, anatomists, surgeons, orthodontists, etc.

The anatomical classification is shown in *Figs.* 1–4. *Fig.* 1 shows some varieties of cleft lip varying from a slight failure of the orbicularis oris of the upper lip to complete bilateral cleft of the lip. *Fig.* 2 shows the degrees of unilateral cleft which increased in severity from cleft lip to a complete cleft of lip, alveolus, and hard and soft palate. This may be right or left sided. *Fig.* 3 shows bilateral clefts which vary in severity from bilateral lip to the most mutilating of all clefts—the complete bilateral cleft of lip, alveolus, and palate. *Fig.* 4 shows the isolated cleft of palate only: again this varies from a submucous cleft of the soft palate to complete cleft of hard and soft palate. These clefts are again subdivided into U shapes and V shapes, the former presenting

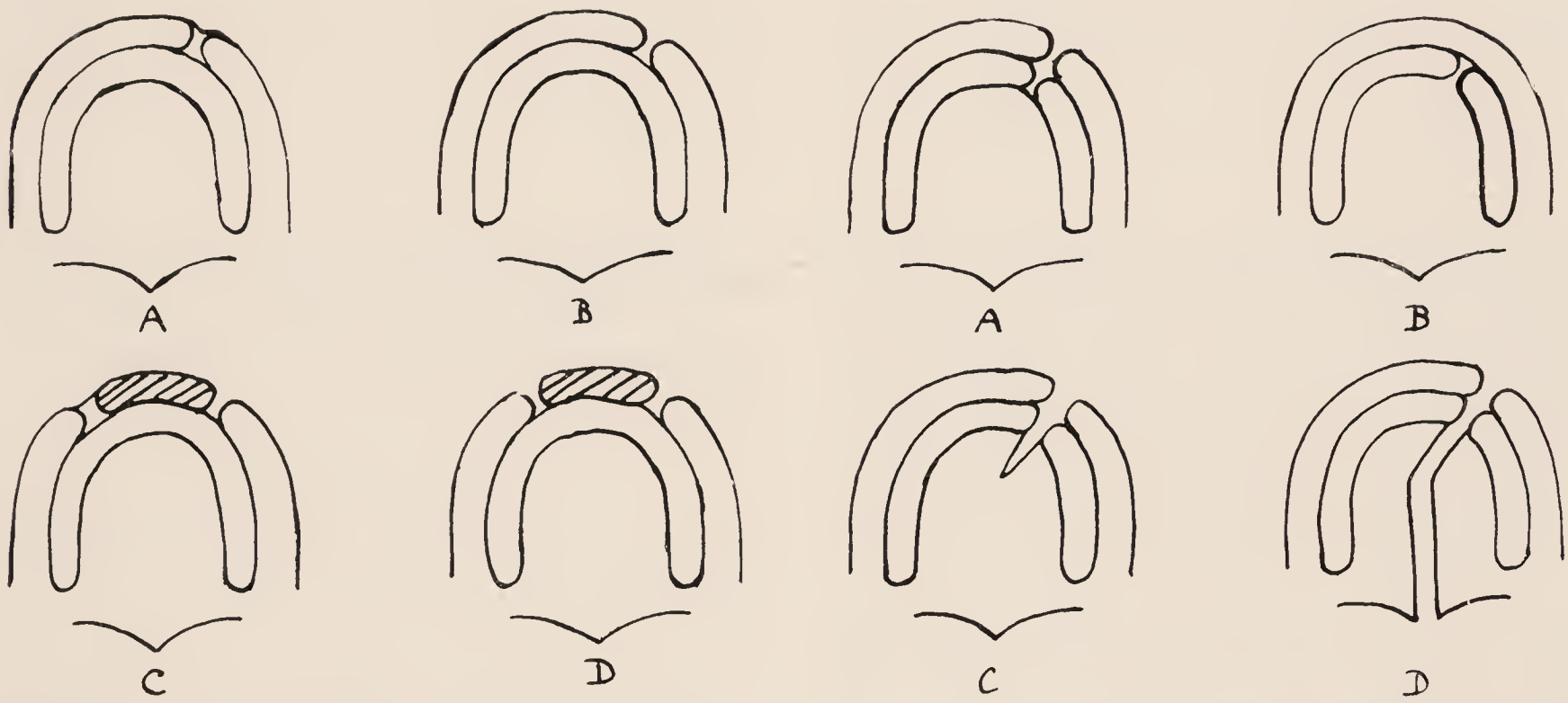


Fig. 1.—Common types of cleft of lip. A, Submucous cleft of lip. The epithelium is intact but the orbicularis oris muscle is cleft. B, Complete cleft of lip. C, Partial bilateral cleft of lip. D, Complete bilateral cleft of lip. The prolabial part of the lip (shaded) contains no muscle tissue.

Fig. 2.—Unilateral clefts of lip alveolus and palate. A, Cleft lip and alveolus. B, Cleft alveolus, lip and palate intact. C, Cleft of lip alveolus and anterior part of hard palate. D, Complete unilateral cleft of lip alveolus, hard and soft palate.

Given at the Manchester meeting held on April 17, 1959.

considerable surgical problems when palatal closure is undertaken.

Embryologically and genetically clefts are divided into clefts of lip and palate, and clefts of palate. The clefts of lip and palate occur before the eighth week of intra-uterine life, while the isolated cleft of palate occurs about the tenth to twelfth week of intra-uterine life. These two clefts occur at different periods of development and have a different genetic background.

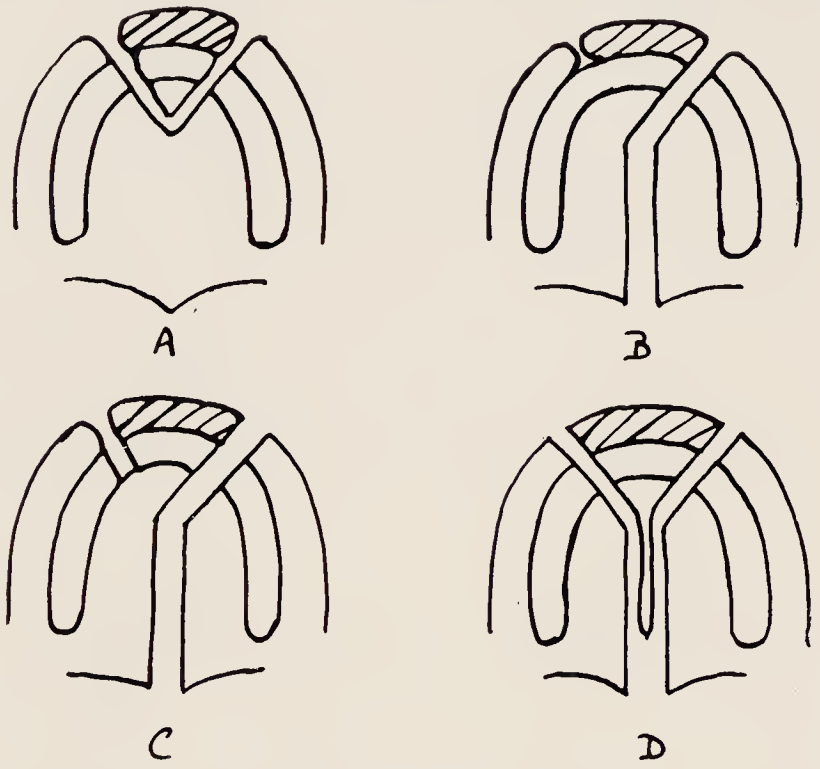


Fig. 3.—Bilateral clefts. The absence of any muscle tissue in the prolabium (shaded) is a constant feature. A, Bilateral cleft of lip alveolus and anterior part of hard palate. The hard palate is intact but the cleft follows the pattern of the premaxilla. B, Bilateral cleft of lip with unilateral cleft of lip alveolus and palate. C, Bilateral cleft of lip and alveolus. Unilateral cleft of palate. D, Bilateral cleft of lip alveolus and palate premaxillary segment is supported by the voma, and the two lateral halves of the maxilla are completely separated.

Having classified the types of clefts, let us now consider the problems which confront the child, and his progress through the early years of life.

The family doctor or midwife is generally the first person to discover that a child has a cleft. The child is then seen at a special centre for rehabilitation of congenitally deformed children.

In "Cleft Centres" the child is seen in the first weeks of neonatal life by a team responsible for the overall treatment plan, who will consider the solution to the combination of problems which confront each individual specialist and whose combined efforts will eventually produce the optimum result when growth is complete.

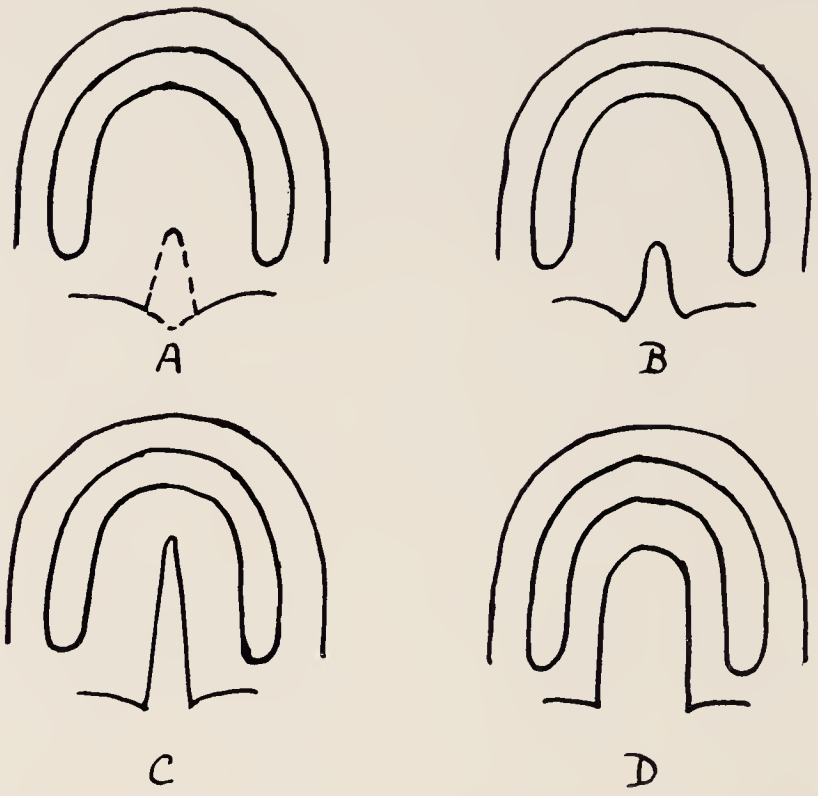


Fig. 4.—Isolated cleft palate. A, Submucous cleft of soft palate; epithelium is intact but there is lack of midline continuity in the muscle of the soft palate. B, Cleft of soft palate. C, V-shaped cleft of hard and soft palate. D, U-shaped cleft of hard and soft palate.

USUAL PROGRAMME

The overall treatment will cover the next 15–20 years of the child's life and will involve some or all of the following:—

Procedure	*Time*
1. Presurgical dental orthopædics	Up to 3 months
2. Surgery, lip closure	3 months
3. Surgery, palate closure	1½ years
4. Dental treatment	From 3 years
5. Speech therapy	From 4 years
6. Dental orthopædics	From 4 years
7. Orthodontics	From 7 years
8. Final surgery	14–16 years
9. Prosthetic treatment	From 16 years
10. Oral surgery	From 21 years

The team of specialists responsible for the rehabilitation of cleft children usually consists of: (1) Plastic surgeon; (2) Speech therapist; (3) Orthodontist; (4) Prosthodontist; (5) Oral surgeon.

Other specialists are of course at hand should their services be needed, e.g., Pædiatrician, E.N.T. surgeon, Psychologist, Radiologist, Anæsthetist, etc., while the family doctor and family dental surgeon must be prepared to devote considerable time to these handicapped children.

Presurgical Dental Orthopædics.—This treatment is carried out in some centres with more enthusiasm than in others. The main object of this treatment is to reposition the segments of the maxilla in the most favourable position and to stimulate normal, and possibly abnormal, growth of the segments, especially the lesser segment in unilateral clefts. In this way contact of the two maxillary segments may be achieved and the deformity due to the lack of tissue is reduced.

In bilateral clefts the early treatment combines the expansion of the two maxillary segments and the repositioning of the premaxillary segment into a position of stability, between the lateral segments.

This treatment is usually carried out in the first few weeks of neonatal life, so that the normal surgical programme is usually not affected.

It is claimed that successful treatment at this age contributes considerably to the final result (McNeil, 1949; Burston, 1958).

Early Surgery.—Opinion differs considerably in different centres as to the most opportune time for lip and palatal surgery.

Early lip closure in the first week of neonatal life is favoured by some teams (Staith and DeKeline, 1938), whereas others delay treatment, especially palatal closure, until after the fifth year (Durrance, 1933; Brodie and Slaughter, 1949). Between these two extremes the usual surgical timing is lip 2–3 months and palate $1\frac{1}{2}$ years.

Those who favour early surgery maintain that the earlier the restoration of normal tissue apposition and function the greater the regenerative and reeuperative powers of the tissues themselves, and therefore the greatest overall benefit. Those who favour late surgery maintain that maximum maxillary growth is established by 5 years, after which any surgical effect on growth will cause limited retardation.

Early surgery is divided into two parts: (1) Lip closure; (2) Palatal closure.

1. Lip closure is usually carried out when the baby is 2–3 months old. The object is:—

a. To restore the continuity of the lip.

b. To unite the orbicularis oris muscle, thus permitting normal function of the circumoral musculature during respiration and feeding.

c. To restore normal blood-supply to the parts concerned.

d. To eliminate the æsthetic disability and thereby help the parents and child socially.

2. Palatal closure is usually carried out before the pattern of speech has been established, i.e., when about $1\frac{1}{2}$ to 2 years old.

The main objects of palatal closure are:—

a. To separate the oral and nasal cavities.

b. To permit palatopharyngeal closure and allow normal deglutition and speech.

c. To unite and restore the function of the muscle of the soft palate before the development of the undesirable muscle movements of defective speech.

d. To permit normal tongue movements and posture.

Anæsthesia.—The anæsthesia of these young children presents a considerable problem. The surgical procedures are never life-saving and therefore the most opportune moment must be awaited. Veau (1938) has accepted a mortality-rate of about 3·5 per cent. To-day under up-to-date conditions a rate of 0·5 per cent or 1 : 200 would not be acceptable.

The presurgical anæsthetic requirements are as follows: The child must be in the best of health and conform to the following data (Davies, Russell, and Danks, 1953):—

1. Be at least 10 lb. and gaining weight.
2. The hæmoglobin must be at least 80 per cent.
3. Be free from all forms of infection, especially upper respiratory infection.
4. The temperature must be normal.

Unless a child can fulfil the above criteria, surgery must be postponed until a later date when they can be fulfilled. It is also important that the operation of lip or palatal closure should not extend beyond one hour from the time of anæsthetic induction to recovery.

With the completion of successful palatal surgery the child has palatopharyngeal closure and a reasonable soft palate with which to develop speech.

Speech—the power of human beings to intercommunicate—is one of the most important

faculties we possess over our primate ancestors, while language is one of the highest manifestations of human intelligence: remove it and our intellectual powers are greatly impoverished.

Speech itself is a most complicated and highly organized faculty, and a fault in one

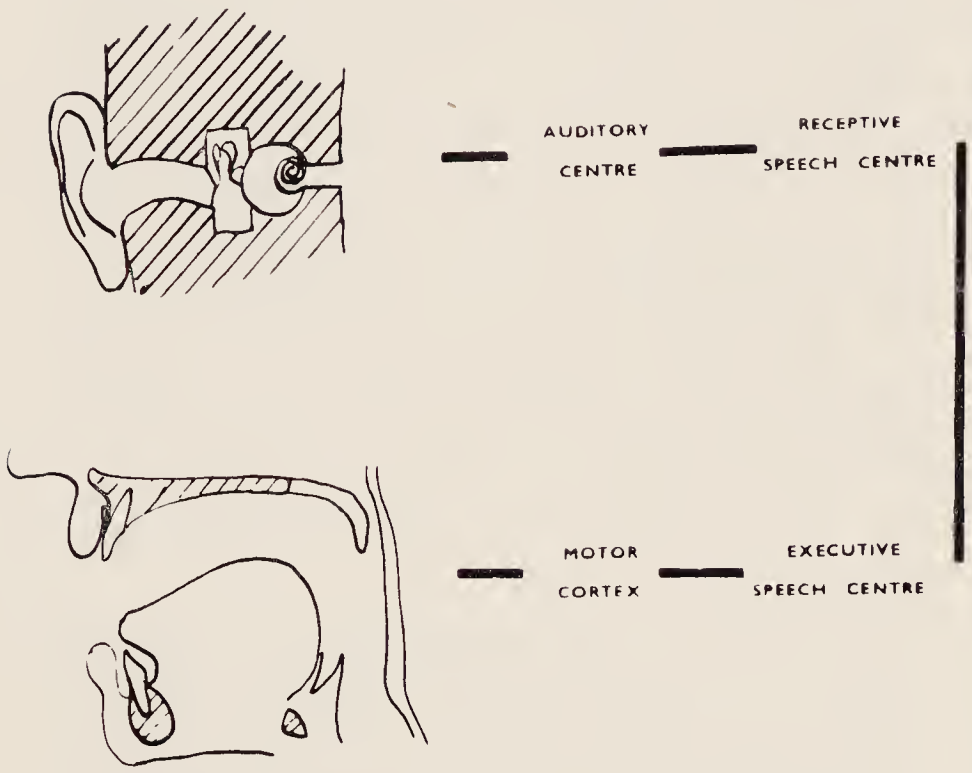


Fig. 5.—Diagram of the main links in the chain of speech. *Above*, The receptive phase. *Below*, The executive phase. A failure in any link in this complicated chain may affect normal speech.

link in the chain of speech can render the person unintelligible.

It is convenient to divide speech into two phases:—

(1) The receptive phase; (2) The executive phase (*Fig.* 5).

The *receptive phase* covers all the processes involved from hearing at the external auditory meatus to the receptive speech centre in the cerebral cortex, and includes transmission of the sound through the middle and inner ear; the nerve impulses pass via the auditory nerve through the auditory centre to the receptive speech centre.

The *executive side* is from the executive speech centre (which initiates the reply and transmits it via the motor cortex) to the muscles responsible for speech—namely, lips, cheeks, soft palate, pharynx, tongue, etc. Added to all this there must be a reasonable intelligence to carry out and co-ordinate this intricate process.

It is not generally realized that the pattern of speech is formed at a very early age. At 1 year a child has a vocabulary of 10 words, at 18 months it has 20 words, and at 2 years it has 200 words, so that it is quite obvious that in order to avoid unusual and atypical muscle habits in speech the soft palate must be united as soon as possible. It is therefore probable that the earlier these tissues are restored to their normal position and function the greater their recuperative powers.

Now, in cleft children we may have one or more weaknesses or even failure in the chain of speech, e.g.:—

1. Deafness is more common than usual.
2. Soft palate may be short, allowing nasal escape (rhinolalia).
3. Soft palate muscles may be defective in function and co-ordination, producing movements too slow for proper speech.
4. Tongue posture and movements may be detrimental to normal speech.
5. Hard palate may have a fistula into the nasal cavity.
6. Maxillary arch may be collapsed, preventing normal tongue movements.
7. Lips may be tight, short, or immobile.
8. Nasal cavity may be reduced in size by maxillary collapse.
9. Intelligence may be subnormal.
10. Personality may be adverse to good speech.
11. Parents' over-anxiety to help may also be detrimental to good speech.

It is obvious that the problems confronting the speech therapist are complicated and obscure and all assistance possible must be given to this member of the cleft-palate team. The therapy is usually started at about 4 years of age, but intelligent parents can give valuable assistance before, during, and after speech therapy: and although considerable improvement can be achieved it must be realized that many will never attain normal speech and some will always be unintelligible.

Dental Treatment.—There is a tendency among the dental profession to avoid the routine treatment of these unfortunate children. This appears to arise from a combination of fear, awe, and repulsion. They feel

they are not capable of carrying out treatment and that it should be done at special centres. This should not be the case. The child should be treated as a normal member of the family and visit the family dental surgeon three times a year with the rest of the family. It is important that they should not feel different from their brothers and sisters.

Treatment itself should start by visits at about 3 years of age. Treatment should be

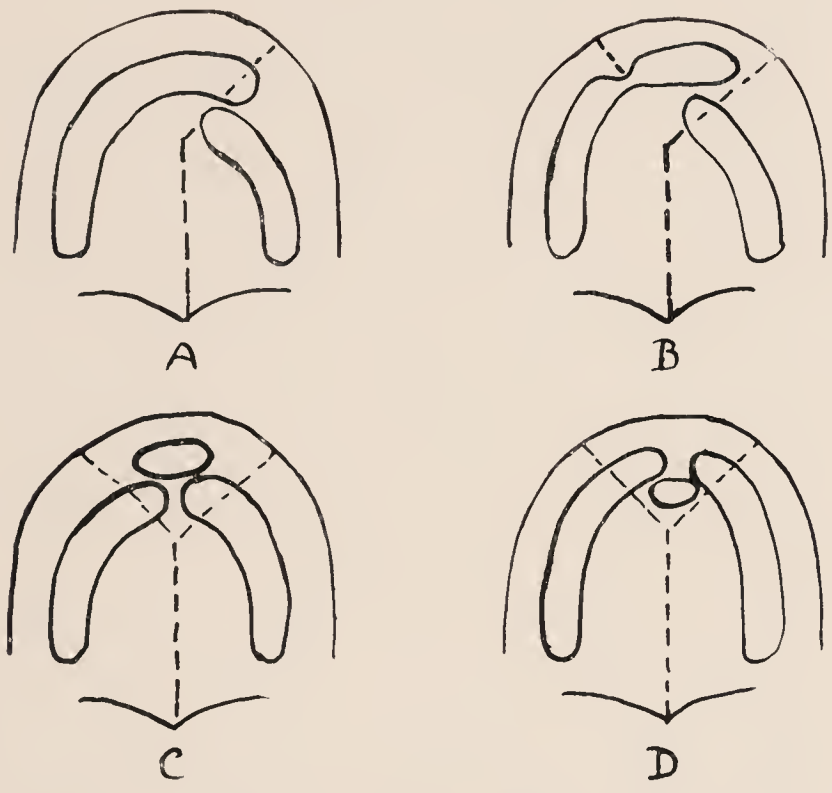


Fig. 6.—Collapse of the maxillary segments in unilateral and bilateral clefts of lip alveolus and palate following surgical restoration of the circumoral musculature. A and B, Unilateral cleft of left side: note collapse of lesser maxillary segment and its overlapping by the larger segment. C, Bilateral collapse of both maxillary segments, excluding the premaxillary segment from the arch. D, The premaxillary segment is overlapped by the maxillary segments. When the premaxillary segment is wedged between the two maxillary segments little collapse of the arch can occur.

very limited, but instruction in oral hygiene is most essential. The services of an oral hygienist is the ideal, but is not always available.

All deciduous teeth must be saved wherever possible, but simple treatment is to be recommended while long, tedious, and possibly painful procedures should be avoided. The extraction of carious deciduous teeth should not be undertaken unless they interfere with sleeping and eating.

The conservation of the permanent dentition is of paramount importance and only the best possible work should be done. The loss of the permanent teeth in cleft-lip and palate patients can produce tragic results in later years when the problems of prosthesis stability become evident.

Tissue Deficiency.—When considering orthodontic problems it must be remembered that in clefts there is a deficiency of tissue and that tissue is considered to be mesoderm. Stark (1945), in his work of cleft embryos, showed the absence of mesoderm and he suggested that clefts were due to lack of mesodermal penetration. The amount of this lack determines the severity of the cleft and may vary from a slight notch in the vermilion border of the lip to a complete bilateral cleft of the lip and palate.

It must also be realized that clefts of lip only and clefts of palate only do not present any real problems to the orthodontist. When, however, the lack of mesodermal penetration is present in lip, palate, and alveolar process, orthodontic and dental orthopædic treatment is invariably necessary. In unilateral and bilateral clefts of lip and palate there is a break in the continuity of the maxillary dental arch dividing the maxilla into two or three segments. Once the lip is surgically united the restored muscle function exerts considerable pressure on this defective arch, with the resulting collapse. The degree of collapse varies from case to case, but is closely associated with the amount of tissue missing (*Fig.* 6).

It must be emphasized that this maxillary collapse is not caused by modern palatal surgery, nor is it influenced by the time at which the surgery is carried out. Multiple palatal surgery carried out by surgeons untrained in modern plastic technique can cause irreparable damage, but these cases are fortunately very rare to-day.

Orthodontics.—This treatment should be divided into: (1) Dental orthopædics; (2) True orthodontics. The object of these treatments is: (*a*) Dental orthopædics aims at restoring the maxillary segments to their normal position, thus obtaining normal articulation with the mandible. (*b*) Orthodontic treatment is confined to individual tooth movement.

Dental orthopædic treatment encourages:—

a. Normal dental function during chewing.

b. Normal muscle movements during speaking, swallowing, etc.

c. Self-cleansing of teeth and lack of caries.

d. Normal nasal dimensions assisting speech and respiration.

e. Normal facial contour.

f. Improves position of collapsed alar base, helping nose shape.

g. With alinement of the maxilla to reasonable normal position, normal environmental factors combined with genetic growth potential will assist to give maximum growth and provide accommodation for the erupting permanent dentition.

Orthodontic Treatment.—Is directed to correction of individual teeth to help æsthetic harmony and normal function and to give arch stability.

It must be realized that the orthodontic problem associated with cleft children may be further complicated by the superimposition of malocclusions which we see in everyday orthodontic practice.

Timing.—Dental orthopædics should be carried out as early as possible, but should be delayed until full co-operation of the patient can be ensured. The age of 4–6 years is the ideal, but if the necessary co-operation is not forthcoming treatment must be delayed until the mixed dentition.

The dental orthopædic treatment repositions the maxillary segments into normal relationships with the mandible and cranial base. This involves swinging the segments outwards against the contraction of the facial muscles. The fulcrum is the craniofacial sutures system of the maxilla, especially the zygomaticomaxillary and pterygopalatine suture systems. It is interesting to note that in most cleft cases the first permanent molars are usually in normal occlusion with the mandible while the pharyngeal width from side to side is greater than normal.

Dental orthopædic treatment should not be started until rapid success is ensured. Maxillary repositioning is usually carried out by movable or fixed appliances and active treatment should take 6–12 months only.

This must be followed by retention of the segments until the permanent dentition is established. Movable appliances, multiband appliances, and silver cap splints are all used. These appliances vary considerably, but great success has been achieved by double-C spring appliances or silver cap splints with single or double-C springs. (Kettle, 1952; Walther, 1954; Glass, 1958.)

The great advantage of the removable double-C spring is that it is simple to construct, easy to adjust, and, most important of all, by closing any anterior palatine fistula is of great help in speech and deglutition.

Orthodontic treatment is usually carried out during the mixed dentition. The treatment is essentially tooth movement and the usual principles of everyday orthodontics apply. The first and most important work is the establishment of an anterior overbite to give a stable incisor relationship and to support the labial segment. This may be followed by a period of retention until the premolars and canines erupt, after which further tooth alinement may be necessary.

This treatment is best carried out by fixed appliances followed by retention. In the majority of this type of cleft case there is malformation or absence of one or more incisor teeth, so that the retention appliance must include the missing tooth or teeth as a prosthesis.

The retention appliance carrying any missing incisor tooth and closing any nasopalatal fistula must always be worn and must eventually be replaced by a metal prosthesis or some form of tooth-bearing bridge to retain space. Loss of this appliance produces immediate and rapid collapse of the maxillary segments, with the corresponding disfigurement, and a reserve retention appliance is a wise precaution greatly appreciated by the patient.

Final Surgery.—Final plastic surgery to the lip and nose is usually delayed until the child has reached at least 14 years of age. Experience has shown that any surgical interference to the nose before this age may cause irreparable damage to the growth potential of the nose, producing a stunted and poor-shaped nose of childish dimensions in an adult face.

Prosthetics.—Most unilateral and bilateral elefts of lip and palate will need a prosthetie applianee to retain the maxillary segments in their eorreet position. These defieieneies can be supplied by a bridge or by a small prosthesis.

In modern eleft-palate planning, speech is given the highest priority with funetion; to this end the soft palate is retropositioned to give palatopharyngeal elosure, if neeessary at the expense of the tissues of the hard palate. An oronasal fistula in the anterior part of the hard palate is therefore often seen. This presents little or no prosthetie problem to elose, but ean be diffieult to elose surgieally.

It is therefore usual to fulfil the neeessary requirement by a temporary prosthesis, whieh ean be replaeed when the dentition has matured by a small metal prosthesis having as little eontaet with the teeth as possible.

Where a palatal fistula exists in a normal dental areh, or where the areh has been restored by a bridge, it can be elosed by a small bung of soft aerylie supported on a palatal plate whieh has no eontaet with the teeth.

True, obturators are oeeasionally neeessary, but they usually indieate that the overall tissue defieieney is too great for normal methods of repair or that the treatment plan has failed.

It is eneouraging that obturators filling large elefts in soft palates are mueh rarer to-day than twenty years ago, and it is hoped that with time they will become a greater rarity.

Oral Surgery.—Many of the severe elefts, espeeially bilateral elefts of lip and palate in whieh the premaxilla has been removed, display a very pronouneed mandibular prognathism whieh is eaused by a large mandible artieulating with a very defieient and even agenetie maxilla. This diserepaney of size is further enhaneed by a forward posturing of the mandible, while the tight and short upper lip is assisted in lip elosure by a large and protruding lower lip.

Bilateral mandibular reseetion to reduce the prognathism gives very pleasing results and lasting gratifieation from the patient.

In adult eases where the soft palate has not been elosed and an obturator is worn, the loss of the maxillary teeth aeting as a prosthetie anehorage is a persistent nightmare to these patients. They well know the problems of retention of the prosthesis when all teeth are lost. New teehniques of metallie implants (Ward, unpublished) have opened up fields of great importanee to these orofaeial cripples and they need not be so eoneerned about prosthetie problems in later years.

INCIDENCE

As has been previously stated, the annual ineidenee of elefts of lip and palate and isolated eleft palate exeeeds 1–1000 live births. This is a high figure, espeeially when one eonsiders that the ineidenee is ten times greater than the ehanee of winning a prize in the Premium Bonds.

Analysis of 650 eases attending the Plastie Centre at East Grinstead shows some interesting faets in the distribution of different types of eleft and in the sex differenee.

It must be noted that the eases represent those elefts which seek treatment at a speeial eentre and will differ somewhat from an analysis of elefts of newborn ehildren. Whereas the sample here analysed will not inelude minor elefts of soft palate whieh need no treatment, nor those people with eleft of lip and palate who do not desire any surgieal treatment, the sample of the newborn will not include the many minor elefts of soft palate and eertainly not the submueous elefts or hard and soft palate whieh may not beeome evident until normal speeeh fails to develop properly at 2–3 years of age.

Table I shows that:—

1. Cleft lip and palate is twice as eommon as eleft palate.

2. Cleft lip and palate is almost twiee as common in males as in females.

3. Isolated eleft palate is more eommon in females than in males.

4. Unilateral eleft of lip and palate is twiee as common on the left side as on the right.

Table II shows that:—

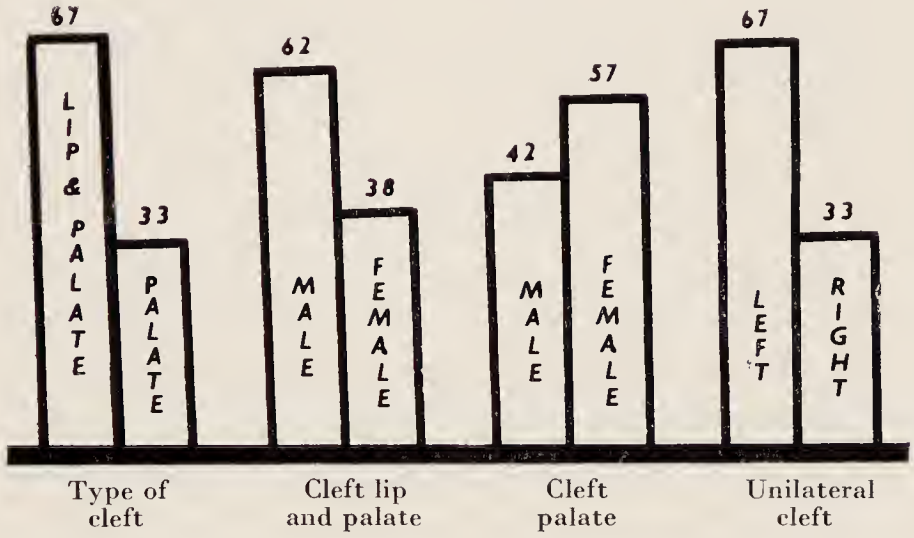
5. Left unilateral, right unilateral, and bilateral elefts are mueh more common in males than in females.

6. In the total of all types of cleft there is a greater occurrence in males than in females.

In view of the sex distribution of clefts it is evident that there will be more males in need of treatment than females, and in view of the greater incidence of the severe clefts, males will require more prolonged treatment with less successful results.

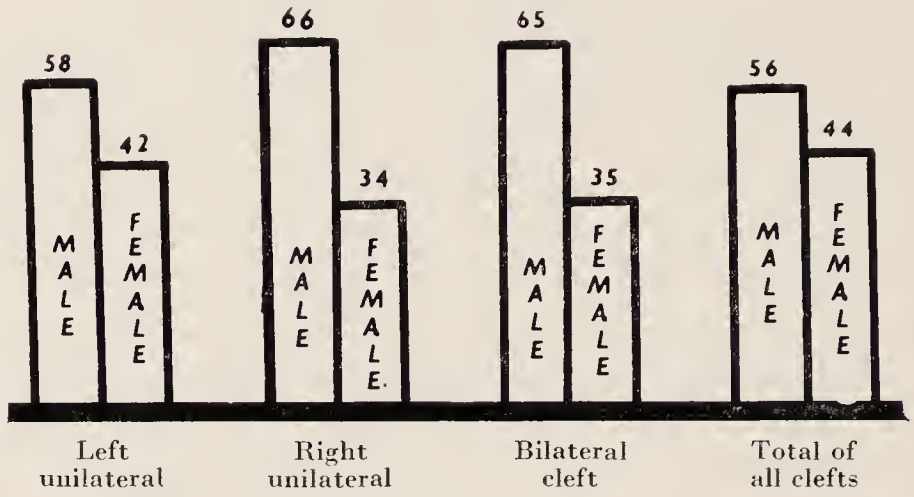
All severe clefts involving the alveolar process will need special extensive dental orthopædic treatment. This number will represent at least two-thirds of all cleft cases or an annual birth-rate of about 500 such cases.

Table I.



It is now recognized that there are two main causative factors in cleft lip and palate—a genetic and non-genetic extrinsic factor—and that cleft lip and palate and isolated cleft palate are genetically different (Glass, 1955).

Table II.



It would seem that clefts occur when certain environmental factors act on a susceptible genotype, and, although many of the non-genetic factors are known, the problem of identifying the gene or genes responsible is unsolved.

The analysis of the gene chemistry and the study of the structure of desoxyribonucleic acid may eventually lead to the identification of the defective D.N.A. molecule which produces the abnormal enzyme, manifest as a developmental abnormality.

Thus susceptible genotypes may be distinguished from normal and selective mating encouraged.

With the recent advances in the treatment of clefts the rehabilitation of the defective child is greatly facilitated and the results so improved that many are now more likely to marry.

Table III.

Parents	First Child	Second Child	Incidence	
			Cleft Lip and Palate	Cleft Palate
1. Normal	Cleft defect	Sibling chance	1 : 25	1 : 71
2. Cleft one parent affected		Offspring chance	1 : 50	1 : 14
3. Cleft one parent affected	Same cleft	Sibling chance	1 : 7	1 : 6

GENETIC COUNSELLING

It is the duty of all concerned with the treatment of congenital deformities to be able to advise on the incidence of these deformities.

If a couple are contemplating marriage and one has a cleft or has a family history of a cleft, then both partners should be made fully aware of the risk they run in perpetuating this defect, so that they can either avoid marriage altogether or certainly avoid reproduction if they think that the risk is too great.

With modern communal treatment at special centres there is a great likelihood of marriage between cleft partners. This immediately presents considerable problems from a national point of view and it is probable that there will be a small increase in the incidence of clefts. This would not be immediately apparent but might be evident over a period of several generations (Fogh-Anderson, 1942).

Table III, taken from Fogh-Anderson's work, is a guide to genetic counselling.

The above table gives a good guide as to the incidence of these cleft deformities and is useful in advising parents. Certain features arise which are of importance:—

1. With normal parents and a cleft first child the chances of a sibling being cleft is three times as great if the defect is cleft lip and palate compared with isolated cleft palate.

2. If one of the parents has a cleft then the chances of the first child having a cleft is three times as great if the defect is isolated cleft palate.

3. If one of the parents has a cleft and the first child has a similar deformity then the chances in siblings is high for both cleft lip and palate. The latter (1 : 6) is extremely high.

4. If one of the parents has a cleft lip and palate and the first child has an isolated cleft palate the chances of the siblings is not increased above the figures for *Table III*.

5. If the father has a cleft lip and palate and the mother has an isolated cleft palate the incidence is not increased for the children above the figures for *Table III*.

It is also evident that females will be able to hide their defects easier than males, are more likely to marry, and thus are more likely to pass on the defect to the next generation.

So far we have considered the physical defects associated with cleft of lip and palate. There remain the mental and psychological problems confronting these orofacial cripples.

Facial disfigurement combined with defective speech attracts the attention of all. Children of the same age ridicule and draw attention to these defects in a cruel manner. The defective child knows he is inferior to his playmates, and this perpetual ridicule creates a depressed and inferior outlook to life. The end-result is lack of self-confidence which creates in time a maladjustment to his surroundings and to society in general. This tends either to produce a recluse or to swing the other way and produce delinquency.

Many parents succeed in bringing up the child in a reasonable manner, but the attitude of some parents, however, is often one of two extremes: They either form a protective screen around their defective offspring to such an extent that the child does very little for itself and when adulthood is reached it is incapable of looking after itself; or the parents, realizing that they have produced a defective child, with the associated social stigma, want to have nothing to do with it and neglect it whenever possible.

All these problems and many others confront the cleft lip and palate patients and his parents. Great misery and suffering is evident, but with modern methods of treatment and better social rehabilitation, the lot of the orofacial cripple is not as grim as it used to be.

SUMMARY

To-day the treatment of cleft children is carried out in a special centre where the various aspects of treatment are planned by the expert concerned. The secret of success depends on early treatment planning and co-ordination of the various aspects of treatment, which must be an integral part of the long-term process of rehabilitation.

With modern techniques and the early analysis of successful and unsuccessful results the future of the orofacial cripple is greatly improved. The incidence of these cleft deformities, however, may tend to increase, and the chance of perpetuating any such defect should be fully understood by a susceptible genotype contemplating marriage.

I would like to express my appreciation for all the help I have received in connexion with this paper from the members of the Cleft Lip and Palate team at Queen Victoria Hospital, East Grinstead, and especially to Mr. Gordon Clementson and his Department for the slides and photographs.

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DISCUSSION

The President thanked Mr. Glass for giving a most interesting talk on a very important problem. He was glad that the author had spent some time stressing the humanitarian aspect.

Mr. Walther: First, I would like to thank Mr. Glass for his paper illustrated by most excellent slides.

I liked his section on Presurgical Dental Orthopædics, with its note of warning that this may not be the complete answer to our problems. It seems to me to be extremely useful in the bilateral cases, but I would suggest caution in the unilateral ones. Here I would like to see it used in only 50 per cent of cases, and the others observed carefully as controls. It is extremely popular with the surgeons because it makes the surgery easier. Provided it makes the surgery more efficient and limits the field of surgical interference, it may be a tremendous advance despite the fear of swinging backwards the larger segment, and thus accentuating the Skeletal III dental base tendency. Time will tell, and I suppose it will be 10–15 years before we know the answer. I would like to hear Mr. Glass's views on this.

As regards the time of operation for the lip, I agree with him that it should be as early as possible—in fact as soon as the baby is fit enough for it. I disagree with him, however, concerning the time of the palate operation. This, I feel, should be delayed until after $2\frac{1}{2}$ years of age, or even later. As he very rightly says, speech is very important and it is mainly speech and the parents' insistence that something should be done that have determined the very early age of operation. At the Hospital for Sick Children, Great Ormond Street, we have operated on a large number of cases after the age of $2\frac{1}{2}$ years, and their speech is certainly no worse for it. On half of these cases we fitted metal cap splints before operation, in order to prevent any collapse due to scar-tissue contraction, etc. This splint was divided about 3 months after operation and the smaller segment swung out with a palatal element and then retained. I would like to know whether Mr. Glass has had any experience of this type of treatment. The main snag, as I see it, is this question of having to begin retention so early. I thought he was being very dogmatic when he said, "It must be emphasized that this maxillary collapse is not caused by modern palatal surgery, nor is it influenced by the time at which the surgery is carried out."

My own experience is that even the best surgery has some effect, maybe only slight, quite apart from the other factors, and this will be less if the operation is carried out rather later.

I also feel that the prognosis of a case not only depends on the severity of the cleft, but also on the inherited skeletal pattern that is present before the cleft deformity has been added.

It is interesting how comparatively uncommon it is to find the parents with a Skeletal II dental base, and yet this Skeletal II base relationship is quite common statistically in a cross-section of the community.

As regards treatment, I was interested in his division into:—

a. Dental orthopædics: To be done as early as possible, i.e., 4–6 years of age. *b*. Orthodontic treatment: Usually done in the mixed dentition.

Personally, I like to group these together and swing out the collapsed segment much later, when I am beginning the other orthodontic treatment, unless I have to retain the case for some other reason. I think the incisor relationship should be corrected fairly early, as this does not require long retention. Then I find that it is usually best to leave the main treatment until the deciduous teeth are all shed. I do not feel that his early dental orthopædic treatment does all that he claims by beginning it early and retaining.

He says that "The first and most important work is the establishment of an anterior overbite to give a stable incisor relationship and to support the labial segment." I agree with this, but I must say that I find it very difficult, in fact usually almost impossible, to treat an anterior open bite in these cases. This seems to become worse with age, and, personally, I can usually only improve it very slightly. I would like to have his views on this.

I agree with him that fixed appliances are not only best but essential if much orthodontic treatment of cleft palate cases is done.

He mentions the question of the oronasal fistula that sometimes develops after operation. I wonder whether it is worth risking this in order to get palatopharyngeal closure. I would like to ask him, "Is this so terribly important for speech?" And has he had any success in closing this fistula with palatal ticklers?

Finally, I am glad that he went into the question of incidence and genetics more fully. It is so important to be able to discuss this with the individuals concerned. As he so rightly says, this deformity is likely to become much more common. I wonder how he proposes to encourage selective mating?

Once again, I would like to thank Mr. Glass for his most enjoyable paper.

Mr. Glass thanked Mr. Walther for volunteering to discuss the paper. Words of wisdom from Mr. Walther

were worth listening to, for he had had a lot of experience in cleft-palate work and his suggestions and disagreements were to be welcomed. After all, orthodontic treatment of these children was still more or less in embryo, and although the work done at different centres might not be strictly comparable, there was something to be learnt from disagreement and argument.

Mr. Glass said he would not be able to answer all the questions asked by the opener because there was not time and, in any event, he did not know all the answers. He could not agree to palatal closure at $2\frac{1}{2}$ years. The child had a speech mechanism at the end of 1 year, and at the end of 2 years words were being formed into sentences. Again Mr. Glass considered that it was wrong to leave a palate open until the age of 5 in order to allow the maxilla to grow. The question of surgical splints was interesting. It would be interesting to see what came out of the work that was being done in this field.

It did not seem as if open bites could be closed, especially in cleft-palate children. As regards the palatal fistula, the soft palate must be closed at the expense of the hard palate. The object was to get the soft palate as far back as possible to obtain palatopharyngeal closure. Mr. Glass explained that although he had used, and was still using, stimulators, he was not entirely convinced of their effectiveness. And the covering of a hard palate fistula was the same prosthetic problem whether the fistula was large or small.

As far as selective mating was concerned, the subject might involve some difficult problems, but undoubtedly it would come. It was done in the first place with animals. All good husbandry was connected with selective mating: no one would think of running a farm without it.

There was no reason why the human race should not do something similar. The arrangement of the bases in the chromosome determined the future of the human being. In the case of a misplacement of a base the result was a congenital deformity and there would be defective cell action. In certain congenital deformities it had been possible to label the gene bases. They had been analysed by "chromosome" fingerprints. In time it might be possible to analyse chromosome fingerprints and forecast that a person had a predisposition to a congenital deformity. If it is illegal for a person to marry a first cousin, presumably there was no reason why it should not be made illegal for one cleft palate to marry another.

Professor C. F. Ballard congratulated the author upon his summary of the problems. They should not at the moment take what was known to be the speech therapist's view, that their speech patterns were laid down. The late Professor Willis had made that point when saying that there was more than failure of normal musculature in these cases.

It was suggested that deciduous teeth broken down should be left at all costs—surely that view was incorrect. Anybody attached to a children's hospital would know that fairly frequently children were admitted who were unwell and running a temperature and it was only as a last resort that the dentist was consulted, and it was then found that apical infection was present. Such infection should not be left in a child's mouth.

The President said that he agreed very much with Professor Ballard. He liked to eradicate sepsis and found it useful to be able to have a competent anæsthetist and to get quite a lot of conservative work done at the same time.

In answer to Professor Ballard, *Mr. Glass* agreed that the problems of speech were very complex and that muscle function formed only a part of the mechanism. Many unoperated cleft-palate cases spoke better than some whose palate was closed and whose palatopharyngeal movements appeared normal. The I.Q. of the patient was one of the most important factors.

Professor Ballard, Mr. Oliver, and the President had all brought up the question of the extraction of broken-down deciduous teeth. Mr. Glass considered that the answer had many facets, partly theoretically and partly practical. First of all it has never been scientifically proved that broken-down deciduous teeth always produce the symptoms claimed by Professor Ballard. There were probably millions of broken-down deciduous teeth in the children's mouths of England which were causing no detectable harm and would be normally exfoliated in due course. If sepsis exists in the mouth it is open sepsis and relatively harmless. The real danger was the closed sepsis of the conserved tooth, with the only outlet being into the blood-stream.

From a practical point of view Mr. Glass would like to ask where the dental manpower necessary to carry out the suggested extraction of these teeth was to come from. And, finally, was it correct to subject these children to the mental and physical trauma of multiple gas extractions with the ensuing loss in confidence of the patient? Mr. Glass thought not, and repeated that only when these teeth interfered with eating and sleeping should they be removed, and should it be necessary to remove an offending tooth then all others of a doubtful character could be removed at the same time.

Mr. D. H. Oliver said he would like to support Professor Ballard up to the hilt. There were far too many doctors and dentists who were sadly unaware of the effects of sepsis from primary teeth—he preferred to call them 'primary' teeth rather than 'deciduous' teeth. The author had shown them a picture of a naval rating when describing what were called "overdentures". It was not stated that the naval rating had any treatment at all for what were quite obviously infected teeth, to which an overdenture was applied.

In reply to Mr. Oliver, *Mr. Glass* said that the merchant seaman had never had extensive routine treatment, and certainly no orthodontic treatment. He refused extensive conservative treatment but did permit the silver nitrating of all exposed dentine.

The teeth although broken down show no apical infection and in fact were nearly all vital despite the appearance. An overdenture was therefore the only answer to this patient's problems.

Mr. A. F. Dee Shapland thanked the author for a most interesting paper. There had recently been one or two cases in Exeter where unilateral cleft was associated with obstruction to breathing by the tongue. The dental surgeon concerned, Mr. W. Selley, fixed a palate into a very young child (a week old) and immediately stopped the trouble. There was a great psychological effect upon the parent because she was able to feed the child. Could such a small palate, attached by two wings to the cheek by adhesive tape, be used as a method of dental orthopædics, and would the author advise it? If so, how and at what age?

In reply to Mr. Shapland, *Mr. Glass* considered that the tongue obstruction was not common except in cases of mierognathia associated with a cleft. The fitting of a small sucking-plate was very beneficial in these cases, and if movement of the maxillary segments was necessary the plate could be constructed to carry this out. The ideal age was as soon after birth as possible. Interesting work

of this kind was being done by Dr. Burton and his team at Liverpool.

Mr. J. C. Ritchie said that the figures of East Grinstead showed there were two chances to one of a cleft occurring on the left-hand side. The world figures showed a proportion nearer to three to one. He had given much thought as to why that should be and had had an opportunity of discussing the question with embryologists in various places. The most satisfactory explanation seemed to be that in embryo the left-hand side of the face formed approximately thirty-six to forty-eight hours ahead of the right-hand side, and if there was a predisposition to cleft, then it was feasible to suppose that it might start on the side of the face which formed first.

On the question of shortage of tissue, one could not be sure that it was fair to assume such a shortage. At about the seventh week of intra-uterine life, it was known that the palatal processes approached one another and finally fused, once the tongue had taken up a more ventral position. As soon as this fusion had taken place there was, in the normal embryo, a considerable lateral expansion or stretching of the tissues forming the palate.

In the case of the cleft, however, if this critical period of fusion was passed, without union, then the lateral expansion of the palate took place in a modified form, without any stretching of the tissues. In other words, once this crisis of palatal fusion had passed, there was then no other opportunity of the palatal tissues to come together.

Would Mr. Glass express his views on those particular points?

Mr. Glass: Mr. Ritchie brought up the question of incidence of left- and right-sided unilateral clefts. The world figure of three left to one right was considerably greater than the East Grinstead figures, but in view of the fact that the 2 to 1 proportion was the same as Dr. Fogh-Anderson's Danish study, the difference in these figures might be due to racial differences.

With regard to the tissue shortage the lack of mesodermal penetration referred mainly to the formation of the lip and primary palate. The process of palatal cleft formation was probably different, it certainly occurred much later and had a different genetic background.

Mr. Glass could not agree that in normal lip formation there was any fusion of processes after epithelial tissue breakdown. He considered that the normal process of lip formation took place by a bulging process of the invading mesoderm, which was followed by angiogenesis. It was angiogenic failure which was probably the cause of the cleft.

With regard to the cleft palate and growth, Mr. Glass considered that after the initial failure resulting in a cleft, all tissues grew and developed normally. Any increase in the cleft size was exactly relative to the increase in size of the surrounding tissues.

Mr. M. A. Kettle felt they should be very grateful indeed to Mr. Glass for bringing his customary gale of fresh air on to the whole subject. As to the timing of operations he himself had been comparing results of lip operations over many years, the performance of the operations having varied from some hours after birth to some years after birth. There was no doubt that the nearer the operation was to birth the greater the deformity in the upper arch. The ideal would seem to be to leave the operation for as long as it could be left, and that was not usually for more than six months. Conversely, the palate operation was better for being performed early. The principle was that the sooner the child had the mechanism to speak (if possible, well before speech started), the better would be the quality of the speech. The approach now was to try to encourage the upper arch to go forward. That movement in itself produced a certain amount of overlapping, as it were, of the upper arch over the lower; and the final movements that were required, not in the temporary dentition but in the permanent one, were not those that required an overall expanding movement.

Mr. Glass welcomed Mr. Kettle's answering remarks. It was essential to maintain a sense of humour when talking orthodontics, and still more essential in this tragic side of our speciality.

He noted that Mr. Kettle was also in favour of early palatal closure, especially before the speech pattern was forming. Mr. Glass considered that the restoration of speech to as near normal as possible is the most important feature of the rehabilitation programme.

With regard to the time of lip closure, and the degree of maxillary deformity, Mr. Glass could not agree that early lip closure always caused greater maxillary collapse —differences in surgical techniques, timing, etc., superimposed on differences in each cleft, made a strict comparison almost impossible.

The problem of repositioning of the maxillary segments involved forward and lateral expansion, the object being to restore as nearly as possible the collapsed segments to the position they would occupy if there was no cleft.

The President said that he appreciated that the discussion could well be continued for some time, but in fairness to the authors of other papers he must draw the discussion to a close.

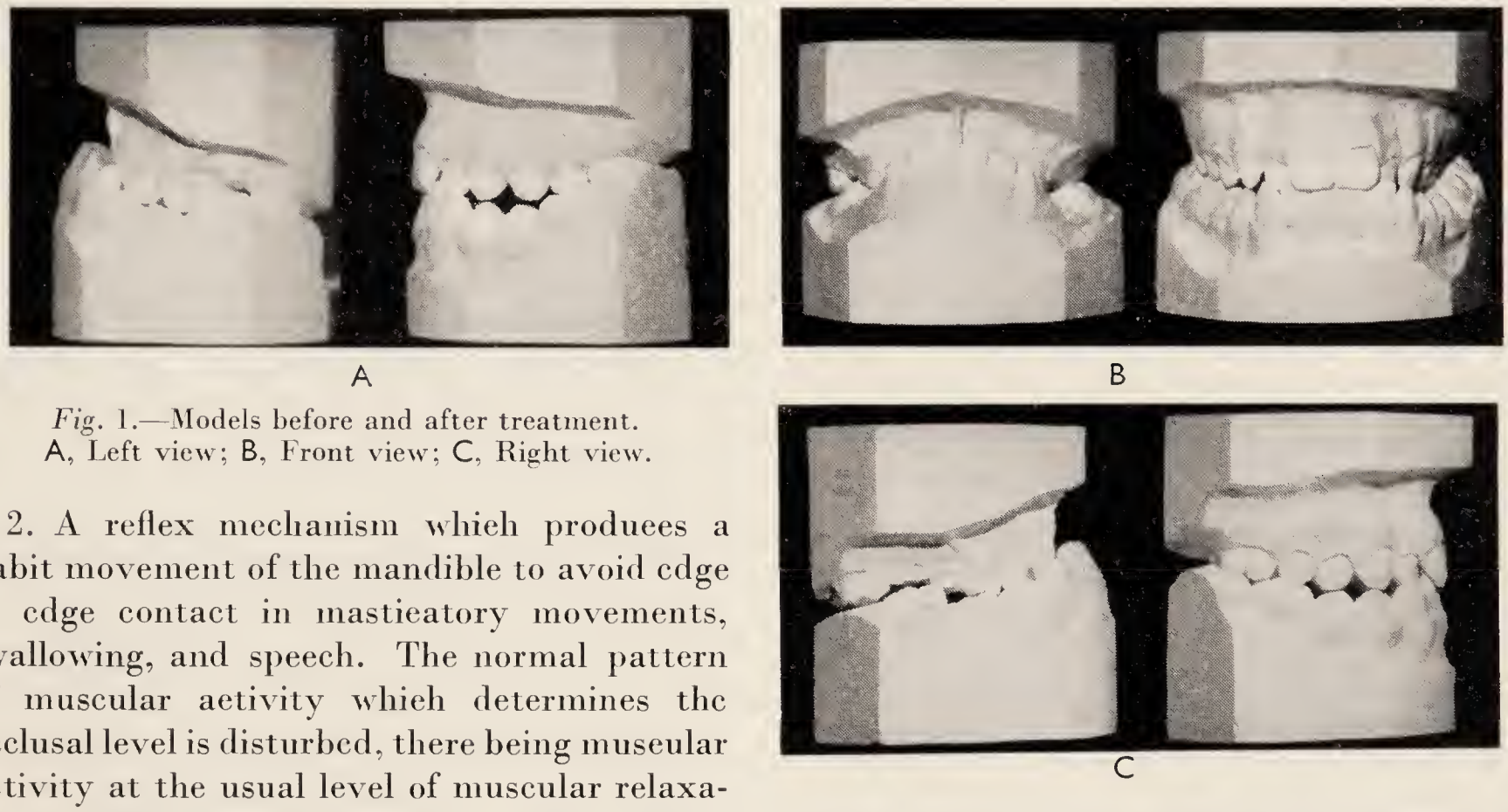
A CLASS III CASE WITH OVERCLOSURE
A CLINICAL AND CEPHALOMETRIC STUDY

By **C. D. PARKER**, B.Ch.D., F.D.S., D.Orth. R.C.S.
Institute of Dental Surgery, The University of London, Eastman Dental Hospital

INTRODUCTION

THE postural Class III type of occlusion was discussed by Ballard (1955), who considered there were two main factors in the production of this type of occlusion:—

1. A skeletal and soft tissue morphology which results in edge to edge contact in the labial segments in the normal path of closure.



A B C

Fig. 1.—Models before and after treatment.
A, Left view; B, Front view; C, Right view.

2. A reflex mechanism which produces a habit movement of the mandible to avoid edge to edge contact in masticatory movements, swallowing, and speech. The normal pattern of muscular activity which determines the occlusal level is disturbed, there being muscular activity at the usual level of muscular relaxation (Ballard and Grewcock, 1954). This results in an occlusion being established at an overclosed position of the mandible.

The resulting excessive intercocclusal clearance can usually be considered as having two components:—

1. The normal amount of intercclusal clearance.

2. The amount of overclosure.

More recently Ballard (1959) has stated that he thinks this picture may be confused by the fact that the failure of labial segment occlusion allows excessive vertical development of the labial segments which encroach on the patient's rest position. This results in a habit posture which is open from rest. If this is so, then in certain cases there is a third component:—

3. The distance between the open habit posture and the true rest position of the mandible.

The treatment of these cases is centred on eliminating the mandibular displacement. This is achieved by altering the abnormal incisal relations. Ballard (1955) has shown that when the abnormal incisor relationship is corrected the occlusal level is altered, with an opening of the maxillary–mandibular plane angle, and with a corresponding decrease in the excessive interocclusal clearance. Both these observations would support the view that the overclosure was the direct result of the mandibular displacing activity. In the cases with a habit posture one would expect after treatment that a new position would be established, the true rest position, closed from the habit posture.

Given at the Manchester meeting held on April 17, 1959.

CASE REPORT

On examination, on April 20, 1955, the patient, aged 8 yr. 10 mth., was found to have a Class III incisal relationship on a skeletal III dental base. The patient was able to bite edge to edge on $\underline{1|1}$ but then moved forward out of contact and into an overclosed

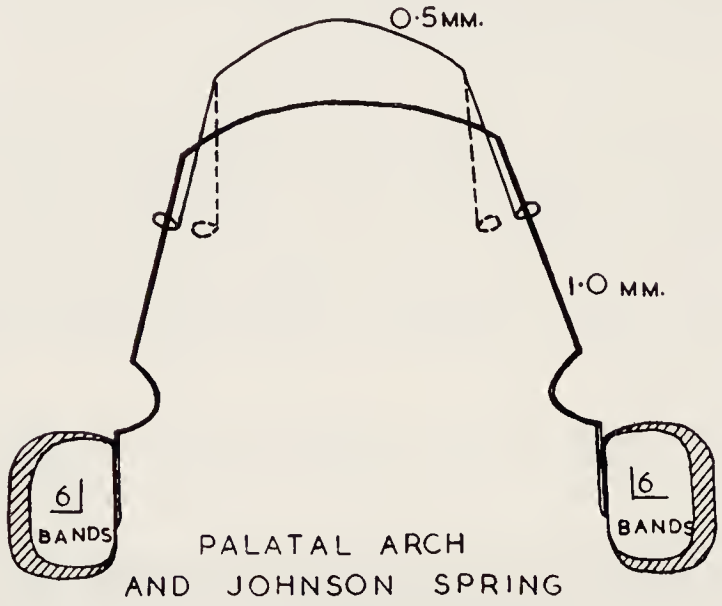


Fig. 2.—Fixed appliance.

occlusal position (*Fig.* 1). Associated with the overclosure was an excessive interocclusal clearance of 14 mm. in the incisor region and 11 mm. in the molar region.

Lateral skull radiographs with lead shot attached to the incisor and molar teeth were taken in three positions: (1) Habit posture l.P. (2) Initial contact 1.I. (3) Occlusion 1.O.

Treatment.—From May 25, 1955, to March 8, 1956, an appliance was worn to procline $\underline{21|12}$ over the bite (*Fig.* 2). No bite opening device was used and no treatment was given to the lower arch. From March 8, 1956, to October 10, 1958, after the active treatment was completed a palatal arch was worn as a retainer.

At examination on November 3, 1958, the patient, aged 12 yr. 4 mth., now presented with $\underline{1|1}$ in Class I occlusion with $\underline{2|2}$ inside the bite (*Fig.* 1). The $\underline{1|1}$ were slightly mobile. The patient could bite edge to edge on $\underline{2|2}$, but the mandible assumed a slight downward and forward habit posture to avoid these teeth. This abnormal incisal relationship may not allow the complete elimination of the overclosure, besides being the cause of a mandibular habit posture instead of rest. The excessive interocclusal clearance was 4 mm. in the incisor region and 3 mm. between $\frac{4}{5}|$. Again, as postulated in the pre-treatment condition, there may be three components, but the second and third, i.e., the amount of overclosure and the amount of open posture, are much reduced. Lateral skull radiographs with lead shot were taken: (1) Habit posture 4.P. (2) Occlusion 4.O.

CEPHALOMETRIC STUDY

An attempt will now be made to try to isolate the effects of treatment. The lateral skull radiographs were traced and two points of superimposition have been used, depending upon the information required.

1. Superimposing on sella (S) and sella–nasion line (S–N) for general facial changes.

2. Superimposing on anterior nasal spine (ANS) and maxillary plane (Mx) when changes occurring in the intermaxillary space, i.e., between the maxillary and mandibular planes (Mx–Md), were the subject of interest. In each case the superimposition point and plane will be indicated.

List of Lateral Skull Radiographs.—

1.P. Habit posture
1.I. Initial contact
1.O. Occlusion
} Before treatment (April 20, 1955).

2.O. End of active treatment Class III occlusion but could bite in Class I occlusion (March 8, 1956).

3.O. Occlusion during retention (January 30, 1957).

4.P. Habit posture
4.O. Occlusion
} After treatment (November 3, 1958), just out of retention.

Growth.—

The growth recorded in this case has two parts:—

1. Normal growth, which would have occurred without treatment.

2. Vertical development of the dento-alveolar structures, which has been responsible for eliminating the overclosure.

Table I.—Readings from Radiographs showing Habit Postures before and after Treatment

	1.P.	4.P.	Difference between 1.P. and 4.P.
N–ANS	55 mm.	59 mm.	+4 mm.
ANS–GN	67 mm.	69 mm.	+2 mm.
N–S–GN	67°	65°	−2°
S–N–GN	79°	83°	+4°
Mx–Md	27°	23°	−4°
SN–GOGN	34°	30°	−4°

The first could have been calculated from rest position lateral skull radiographs before and after treatment. Unfortunately in this case I believe that rest position was not recorded in either case, but habit postures were, and therefore using these lateral skull tracings any distance changes or changes in

angles would represent normal growth and change in habit posture (*Table I*).

The sum of (1) and (2), i.e., normal growth and vertieal development, is readily obtained from the ocelusal level radiographs before and after treatment (*Table II*).

1. *Normal Growth and Postural Changes* (*Fig.* 3).—4.P. on 1.P. superimposed on S and (S–N) line.

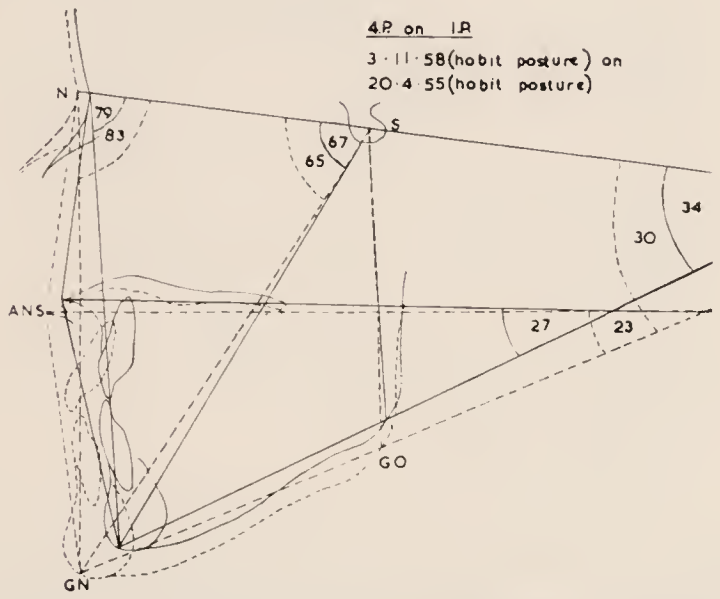


Fig. 3.—Superimposed radiograph traeings of habit postures before and after treatment, showing normal growth and ehange of habit posture.

Distance Changes.—From *Table I* it will be seen that while the N–ANS distanee inereased by 4 mm. the ANS–GN distanee only inereased by 2 mm. Growth studies in this age range have been earried out by Brodie (1953) and Meredith, Knott, and Hixon (1958). The latter workers ealculated mean values and individual variation for the index.

$$\frac{\text{Nasal Height} \times 100}{\text{Subnasal Height}}$$ at various ages.

From ealculations based on this work I would have expeeted an inerease of 3–4 mm. in the ANS–GN distanee.

Angular Changes.—In *Table I* the following angles deereased during the treatment period: N–S–GN by 2°, Mx–Md by 4°, and SN–GOGN by 4°. Brodie (1953) in his growth study found in one ease only out of 19 a deerease in the N–S–GN angle. Although one eannot prediet growth, the small inerease in ANS–GN distanee plus the deerease in N–S–GN angle along with a 4° deerease in the Mx–Md angle are to me suggestive of normal growth and ehange in habit posture rather than growth alone. The condylar and rotation axis ehanges whieh are mentioned later would also tend to bear this out.

2. *Normal Growth and Vertical Development of the Dento-alveolar Structures* (*Fig.* 4).—4.O. on 1.O. superimposed on S and (S–N) line.

Distance Changes.—From *Table II* it will be seen that while the N–ANS distanee inereased by 4 mm. the ANS–GN distanee inereased by

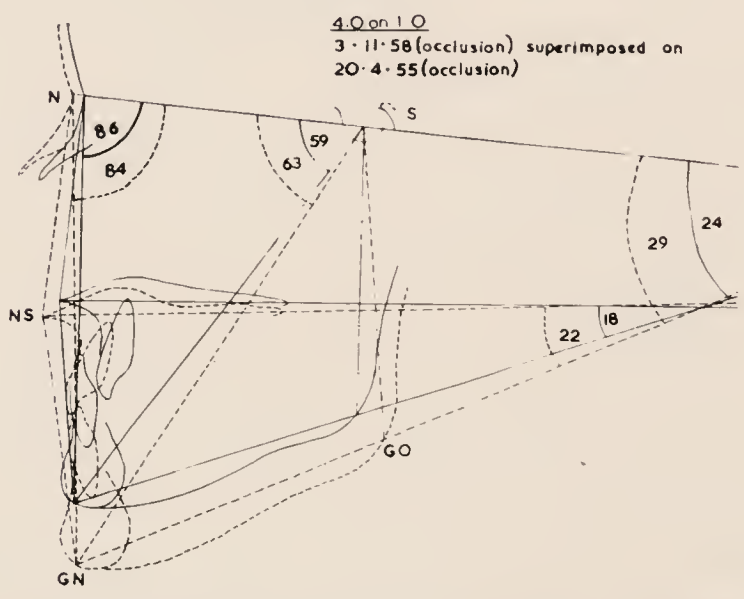


Fig. 4.—Superimposed radiograph traeing of ocelusion before and after treatment, showing normal growth plus vertical development.

13 mm. The ANS–GN inerease is far too great to be aeeounted for by normal growth (Meredith, Knott, and Hixon, 1958). I think the explanation lies in the elimination of the mandibular overelosure, although to this must be added normal growth. Working on mean figures it would appear that the overelosure was somewhere in the order of 10 mm. and normal growth around 3 mm., whieh gives

Table II.—Readings from Radiographs showing Occlusion before and after Treatment

	1.O.	4.O.	Difference between 1.O. and 4.O.
N–ANS	55 mm.	59 mm.	+ 4 mm.
ANS–GN	53 mm.	66 mm.	+13 mm.
N–S–GN	59°	63°	+ 4°
S–N–GN	86°	84°	− 2°
Mx–Md	18°	22°	+ 4°
SN–GOGN	24°	29°	+ 5°

us the 13 mm. total increase in ANS–GN distance.

Angular Changes.—A study of *Table II* shows the following angles increased during the treatment period: N–S–GN by 4°, Mx–Md by 4°, and SN–GOGN by 5°. There was a decrease of 2° in the S–N–GN angle. Brodie (1953) in his growth study never found a

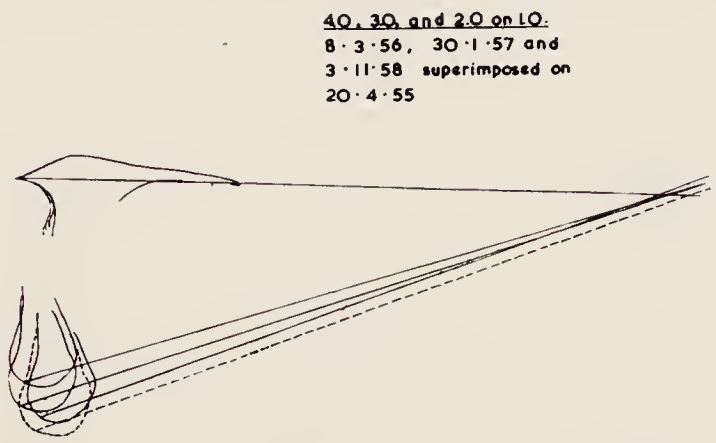


Fig. 5.—Superimposed radiograph tracing of occlusion before, during, and after treatment, showing progressive vertical development.

decrease in the S–N–GN angle. The large increase in the ANS–GN distance would suggest an additional factor to normal growth, which I believe is the elimination of an overclosure (Ballard, 1957).

The above changes, I think, represent normal growth and the vertical development of the dento-alveolar structures in the elimination of the overclosure, following treatment.

3. *Progressive Vertical Development* (*Fig.* 5).—1.O., 2.O., 3.O., and 4.O. superimposed on ANS and Mx.

Table III.—Further Readings from Radiographs showing Occlusion before, during, and after Treatment

	ANS–GN	Mx–Md	ULS–Mx	LLS–Md
1.O.	53 mm.	18°	106°	75°
2.O.	59 mm.	20°	117°	72°
3.O.	63 mm.	22°	117°	74°
4.O.	66 mm.	22°	118°	74°

The figures in *Table III* show that there has been a progressive increase in the size of the intermaxillary space with an opening of the Mx–Md angle. During the period of active treatment the upper labial segment was proclined 11° in order to move the teeth over the bite. Since then there has been virtually no change of axial inclination. The lower labial segment inclination is also virtually unchanged after treatment.

4. *Initial Contact and Final Occlusal Level* (*Fig.* 6).—4.O. on 1.I. superimposed on S and (S–N) line.

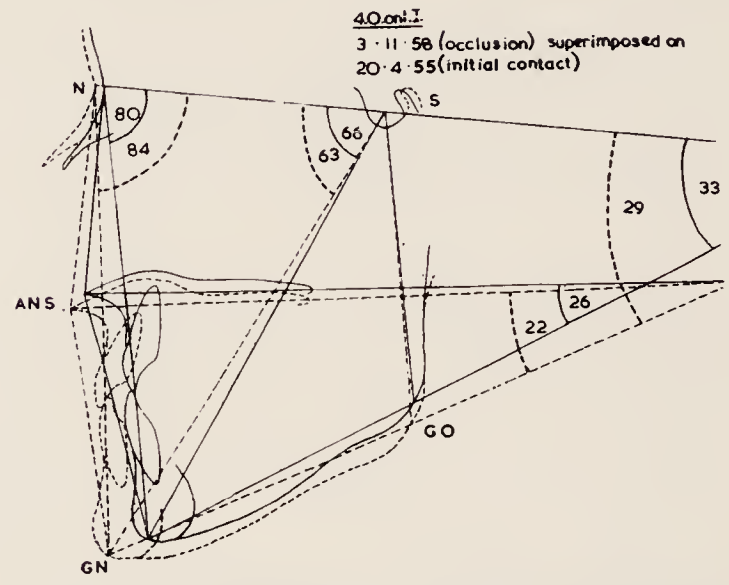


Fig. 6.—Superimposed radiograph tracings of initial contact before treatment and occlusion after treatment, showing possible overclosure or excessive vertical labial development.

In *Table IV* it will be seen that the ANS–GN distance is unchanged when comparing the initial contact before treatment and the occlusal level after treatment. By way of explanation, I feel two factors should be considered:—

Table IV.—Readings from Radiographs showing Initial Contact before Treatment and Occlusion after Treatment

	1.I.	4.O.	Difference between 1.I. and 4.P.
N–ANS	55 mm.	59 mm.	+4 mm.
ANS–GN	66 mm.	66 mm.	0 mm.

a. Possible slight overclosure still present.

b. Possible excessive vertical development of the labial dento-alveolar structures before treatment.

It may well be that both factors are involved to some degree.

5. *Changes in the Interocclusal Clearance.*—This analysis is based on the technique described by Nevakari (1956).

a. Before Treatment (*Fig.* 7 A).—
Incisor interocclusal clearance=14 mm.
Molar interocclusal clearance =11 mm.

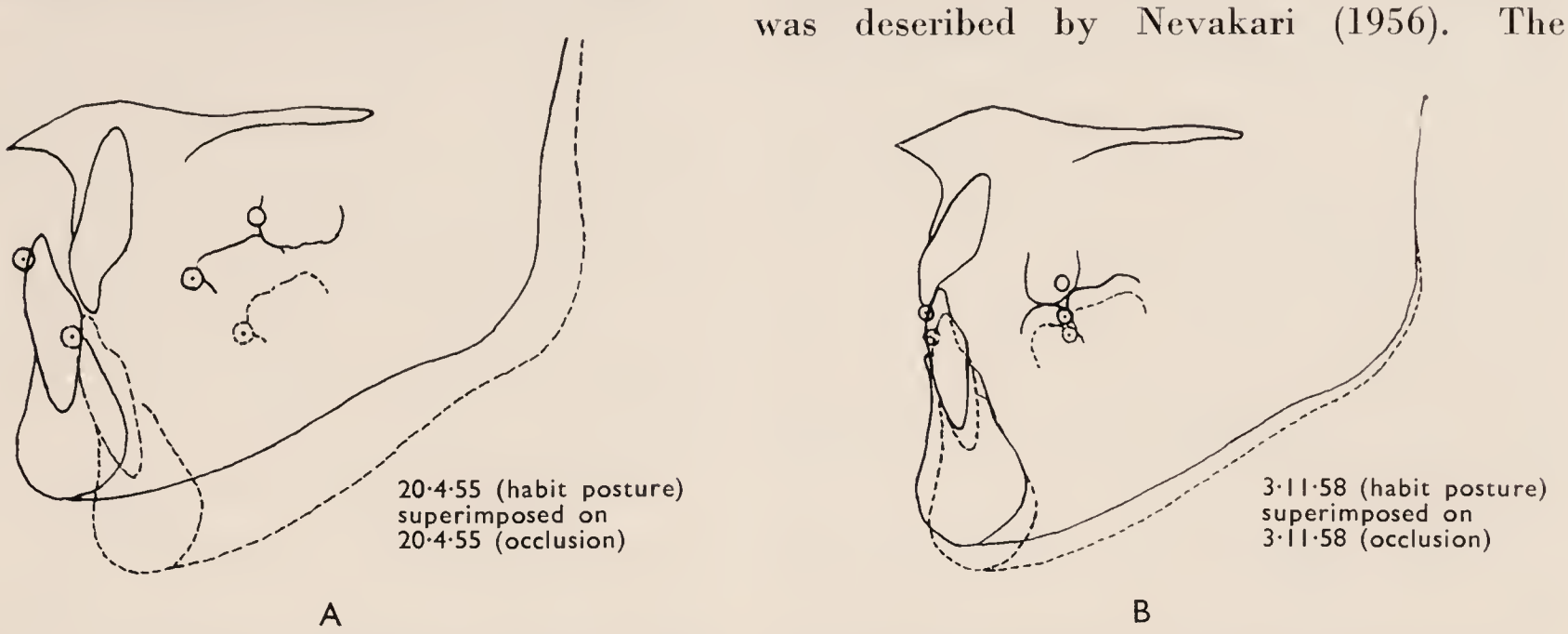


Fig. 7.—Superimposed radiograph tracings of habit posture and occlusion showing excessive interocclusal clearance. A, Before treatment; B, After treatment.

b. After Treatment (*Fig.* 7 B).—
Incisor interocclusal clearance=4 mm.
Molar interocclusal clearance =3 mm.
Reduction in Interocclusal Clearance.—
Incisor region=14 mm.–4 mm.=10 mm.
Molar region =11 mm.–3 mm.=8 mm.

expressed in terms of a geometric rotation axis. This, however, does not mean that the mandible rotates on a hinge axis. The method was described by Nevakari (1956). The rotation axis is the intersection of the perpendicular bisectors of the lines joining the centres of the lead shot at habit posture and occlusion.

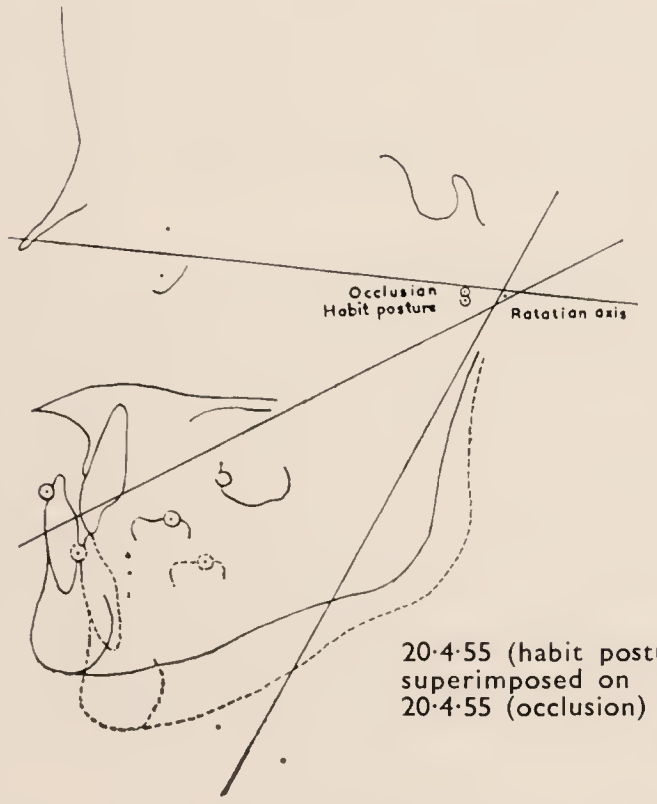


Fig. 8.—Superimposed radiograph tracing of habit posture and occlusion before treatment, showing mandibular rotation axis and condylar movement.

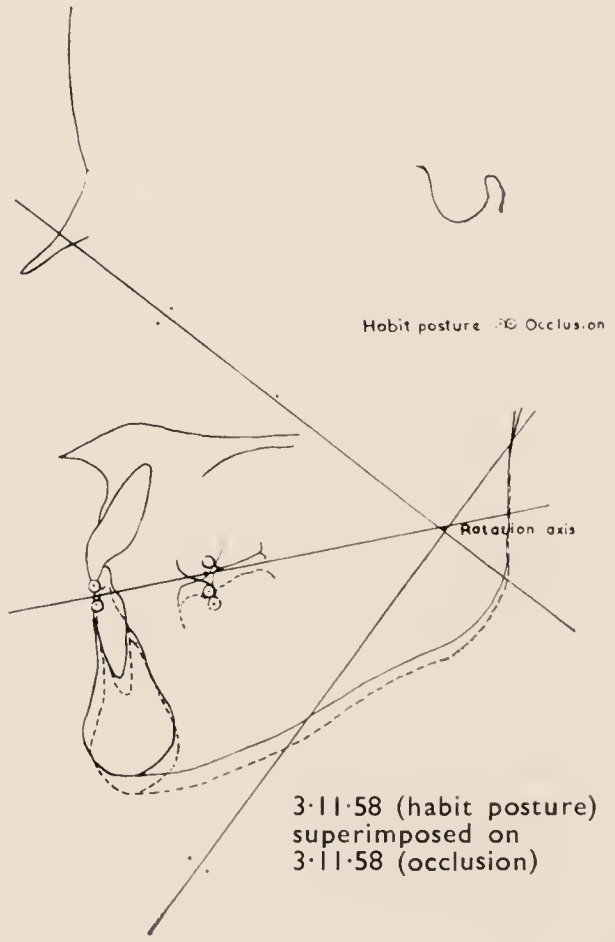


Fig. 9.—Superimposed radiograph tracing of habit posture and occlusion after treatment, showing mandibular rotation axis and condylar movement.

6. *Rotation Axis from Habit Posture to Occlusion.*—The sum of all movements from rest or a habit posture to occlusion can be

a. Rotation Axis, Before Treatment (*Fig.* 8).—This was located just behind the head of the condyle.

b. Rotation Axis, After Treatment (*Fig.* 9).—This was found to be in the middle of the ramus.

A change of rotation axis suggests that the four positions of the mandible recorded (two before and two after treatment) cannot all be in centric jaw relationship. It is impossible to say which or how many of the four positions are not centric jaw relations.

7. *Condylar Movements from Habit Posture to Occlusion.*—

a. Before Treatment (*Fig.* 8).—1 mm. upward movement of the condyle from habit posture to occlusion.

b. After Treatment (*Fig.* 9).—2 mm. backward and slightly downward movement of the condyle from habit posture to occlusion.

Both these condylar movements would be in accord with a habit posture instead of true rest position. Before treatment an open habit posture and after treatment a slightly forward and open posture.

SUMMARY

Following a change in incisal relations from Class III to Class I by proclining the upper labial segment:—

1. The interocclusal clearance decreased by 10 mm. in the incisor region and 8 mm. in the molar region. Before treatment the excessive interocclusal clearance was considered to have three components which have been termed: (*a*) Normal, (*b*) Overclosed, and (*c*) Open posture. Treatment was thought to considerably reduce if not completely eliminate the overclosure and at the same time was responsible for a change in the open posture.

2. The distance between anterior nasal spine (ANS) and gnathion (GN) with the teeth in occlusion has increased by 13 mm. This has been progressive with an increase in the maxillary–mandibular plane angle (Mx–Md) from 18° to 22°.

Two factors are involved:—

a. The normal growth process has contributed at least 2 mm.

b. Vertical development of the dento-alveolar structures due to a new level of balance for masticatory muscle pressure and the inherent tendency of dento-alveolar vertical development. This was responsible for approximately 10 mm. The vertical development opened the Mx–Md plane angle.

Therefore, the part played by vertical development of the dento-alveolar structures following the change in incisal relations is largely responsible for the reduction if not complete elimination of the overclosure.

3. The ANS–GN distance is the same in the initial contact level before treatment and the occlusal level after treatment. Two factors should be considered:—

a. Possible vertical development to occur and overclosure to be eliminated, or

b. Possible excessive vertical development of the labial segments before treatment, there being no overclosure now present.

4. A change in the rotation axis before and after treatment is significant. This suggests that the habit postures and occlusal positions recorded before and after treatment cannot all be in centric jaw relationship.

5. Changes in the degree and direction of condylar movement. Before treatment 1 mm. upward movement from habit posture to occlusion as compared to 2 mm. backward and slightly downward movement after treatment. Both these would suggest habit postures were assumed by the mandible before and after treatment.

Acknowledgements.—I am very grateful to the radiographic and photographic departments of the Eastman Dental Hospital and to Miss S. B. Magarshack for preparing the illustrations. I would like to thank Mr. J. R. E. Mills for his help and Professor C. F. Ballard for advice and criticism and for permission to publish this case, which was treated at the Eastman Dental Hospital, London.

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DISCUSSION

The Chairman thanked the author for presenting so well and so thoroughly a noteworthy case. Such a case was fascinating, but it was extremely difficult to assess the postural position.

Professor C. F. Ballard said he would like to congratulate Mr. Parker on this exercise in reasoning. He agreed with the reasoning. Perhaps others would concur in the view that it was necessary for such a paper to be printed and read in order to be fully appreciated. The paper had two particular aspects. One was its illustration of how lateral skull radiographs could be used for an analysis of what was happening during orthodontic treatment; but more important was its illustration of the way in which the analysis of radiographs could help to confirm, or otherwise, clinical concepts of mandibular posture.

The author had been trying to reason that there was in fact a true rest position for every individual, and here we had a disturbed rest position as a result of the occlusal abnormality, and when that was corrected the mandible would return and assume its true rest position, and the occlusal level had a definite relationship to that rest position. That reasoning was not as important to them as orthodontists as it was to the prosthetists. It was up to them to put forward all the evidence they could to help the prosthetists to come to a true physiological understanding of the true rest position.

Mr. Parker had pointed out that the final occlusal position might have been confused. A tremendous amount of vertical development would have taken place and it was possible that the original excessive vertical development had been completely eliminated. While Professor Ballard agreed with the author's reasoning, there were no doubt others who did not agree with it, and he would leave the author to them.

Mr. Steel asked what change in balance had taken place to allow the upper incisors to change without the lower incisors.

Mr. Parker said there had been a change in the inclination of the lower labial segment to the mandibular plane as a transient condition during treatment. With a change of mandibular posture and path of closure it might allow the position of balance to be slightly different from that of the before treatment condition.

Mr. A. J. Walpole Day said there was shown to be a change in the rest position and also in the occlusal level and those two changes had taken place at the same time. Professor Ballard suggested there was a relationship between the rest position and the occlusal level and rather hinted that the occlusal level changed because the rest position changed. Was it not true that there must be some relationship between the number of teeth in the occlusion and the occlusal level?

Mr. Parker believed that the number of teeth in contact was not important. The way they came into contact was the important fact. In the case presented the change in position of two teeth, the upper central incisors, had caused the change in occlusal level.

Mr. W. J. Tulley thanked the author and said he felt the subject matter was confusing because there were so many variables—growth, the habit postural position which it was difficult to assess, and the true rest position. He noted that there were three years between the radiographs. It would have been interesting to have had a radiograph immediately after the incisor relationship was corrected and to have noted the habit-posture change. The paper required careful reading so that the figures and the complex tracings could be closely examined. He would like to see one of these cases analysed in a similar way on a skeletal 1 base.

Mr. Parker said that he had not got a lateral skull tracing of the rest position or posture immediately after correcting the incisal relations, but only a recording of the occlusal level that was shown in the progressive vertical development. It would have been very interesting to have had such a record.

Mr. Jason Wood thanked Mr. Parker and asked whether he had known what was going to happen before he began treatment. There seemed to be quite a lot of similar cases where the incisor relationship was altered satisfactorily and the occlusal level did not rise, and he could not distinguish between the cases. Would the author enlighten him?

Mr. Parker said that the results were anticipated in so far as lateral skull tracings were taken.

Mr. Jason Wood said his question had not been answered. The result was foreseen, but how could one tell that sort of case from one where the intra-occlusal space did not alter?

Mr. Parker said that in certain cases there was a persistent excessive interocclusal clearance due to localized lack of development, and one could not predict this with certainty. However, in both types the early treatment of change of incisal relations was indicated. In most cases one would then expect vertical development of the buccal segments.

Mr. H. E. Wilson said the author assumed that the first position was a postural forward position and that the mandible moved upwards because of the forward posture. Could that not have been the true resting position and, because of the changed occlusion, might there not have been displacement of the mandible?

Mr. Parker said he would like to show again a slide that indicated the incisor relationship after treatment. (*Slide shown.*) This diagrammatic representation might be slightly exaggerated but undoubtedly the lower labial segment now appeared to occupy a position between the upper central and lateral incisors. The patient for some reason or another found this posture comfortable and in order to produce occlusion the mandible moved upwards and forwards.

Mr. Tulley observed that he thought the answer as to whether there was a lateral postural position could be determined with the electromyograph.

Mr. Parker said he realized that he was only presenting his findings on the analysis of one case. He would not come to any definite conclusions, but an indication was produced which tied in with some of his thoughts on the subject.

Professor Ballard said that the paper required further consideration. It was important to prove or disprove that the true rest position must be on a hinged axis movement and a distal displacement was quite separate from that. A displacing activity was quite distinct from a hinged axis movement.

The Chairman thanked Mr. Parker for his paper and answers to the discussion.

A CLASS III CASE TREATED WITH SIMPLE APPARATUS

A CASE REPORT

By **D. G. GOULD**, B.D.S., F.D.S., D.Orth. R.C.S.
Senior Registrar, Eastman Dental Hospital, London

THIS is the report of a Class III case which was treated by means of upper removable appliances and a lower fixed appliance in the comparatively short period of eight months.

The patient was first seen in December, 1953, aged 9, when the following observations were made.

"Dental base relationship Class III, occlusal relationship Class III (Angle). The lower right first permanent incisor and the left first and second permanent incisors and deciduous canine ($\overline{1|12C}$) oeclude labial to the upper incisors. The lower right canine is rather upright and would be difficult to move distally and it might be better to extract lower right second incisor, upper right first premolar and upper and lower left first premolars, instead of four first premolars ($\frac{4|4}{2|4}$)."

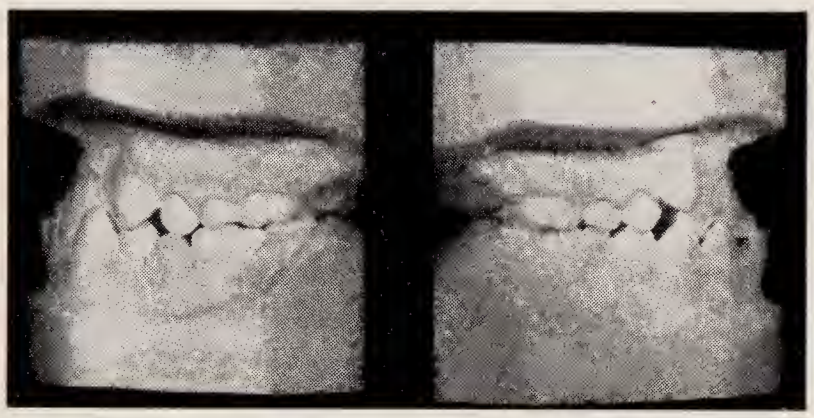
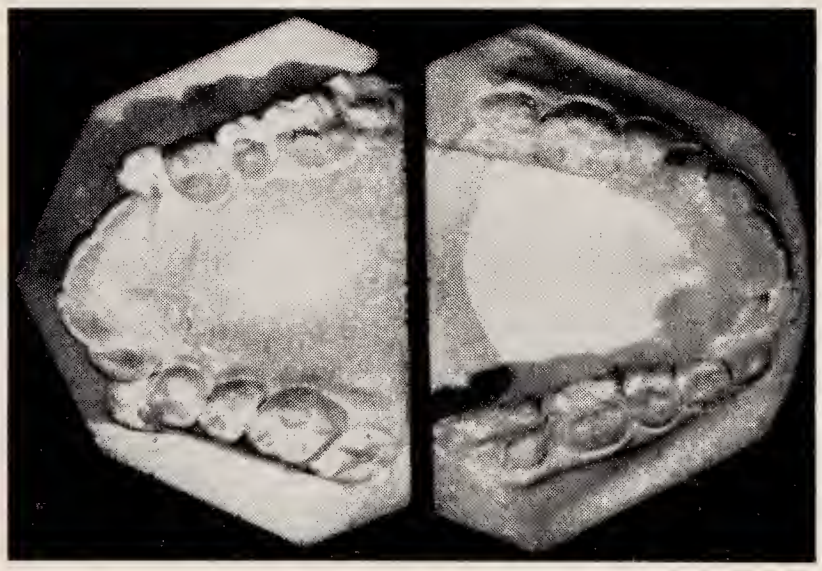
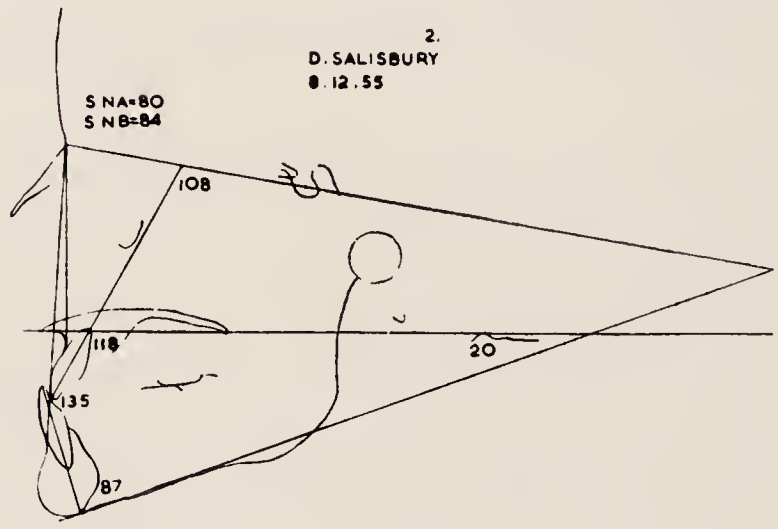


Fig. 1.—Lateral views of study models, before treatment, December, 1955.



A



B

Fig. 2.—Occlusal view of A, models and B, tracing of lateral skull radiograph, before treatment, December, 1955.

It was decided to delay treatment until all the premolars and canines had erupted, and so two years later in December 1955, at the age of 11, the three premolars and the lower incisor were extracted and treatment was started (*Figs.* 1, 2).

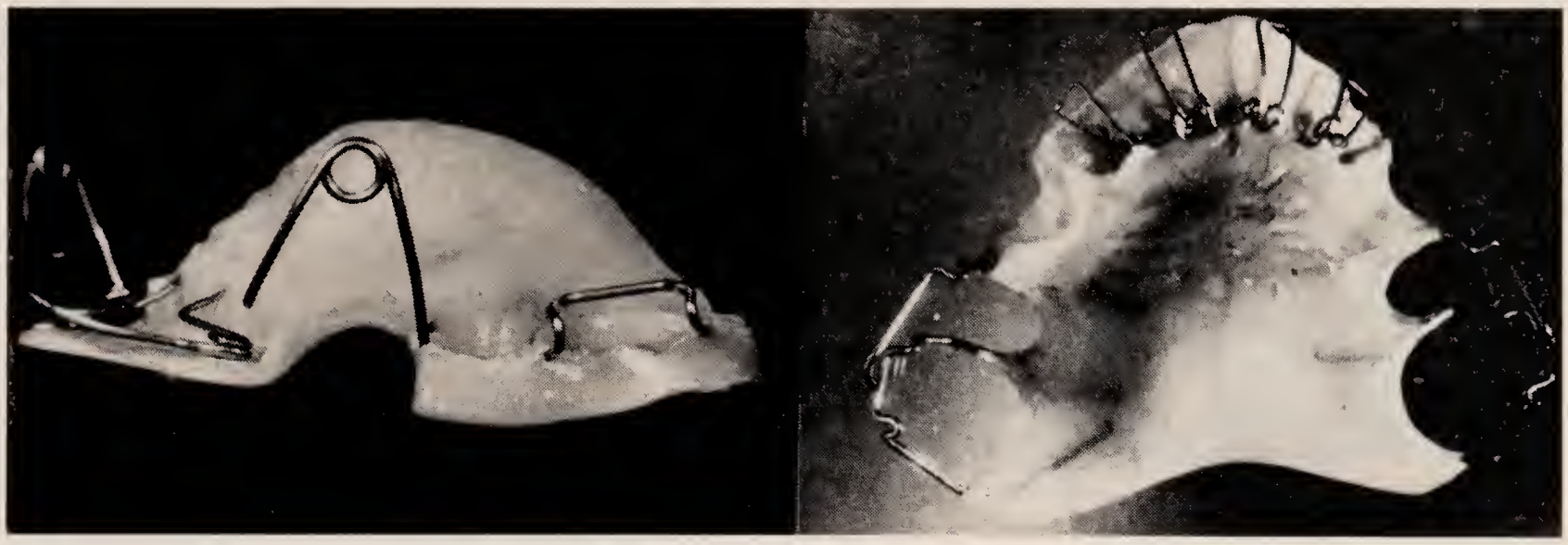
The tracing shows the upper incisors were relatively proclined at 118° to the maxillary plane. (Average 109°.) The lower incisors were relatively lingually inclined at 87° to the mandibular plane (the average on a maxillary–mandibular plane angle of 20° would be about 100°) and that the SNA angle was 80° and the SNB was 84°, a difference of —4°.

maxilla is relatively underdeveloped, but the mandible is not abnormally large. The soft tissue patterns of behaviour are normal. There has been early loss of deciduous molars and this has resulted in forward shift of all four first permanent molars.

Active treatment was started in January, 1956, when an upper removable appliance was

Given at the Manchester meeting held on April 17, 1959.

fitted to retract the canines. The appliance was also fitted with finger springs to procline for distal movement with intramaxillary elastics.



A B

Fig. 3.—A, Upper removable appliance with buccal springs to retract the canines, palatal springs to proeline the incisors, and buccal bite blocks. B, Palatal view of removable appliance showing flapper springs to proeline the incisors.

the upper incisors and buccal bite blocks to prop open the bite. In two months the canines were retracted sufficiently and proclination of the upper incisors was started (*Fig.* 3 A).

In April, 1956, bands were cemented on to the lower buccal teeth and retraction of the lower left canine was started by means of a push coil tied back on a round wire arch in order to provide space for alinement and retraction of the lower incisors.

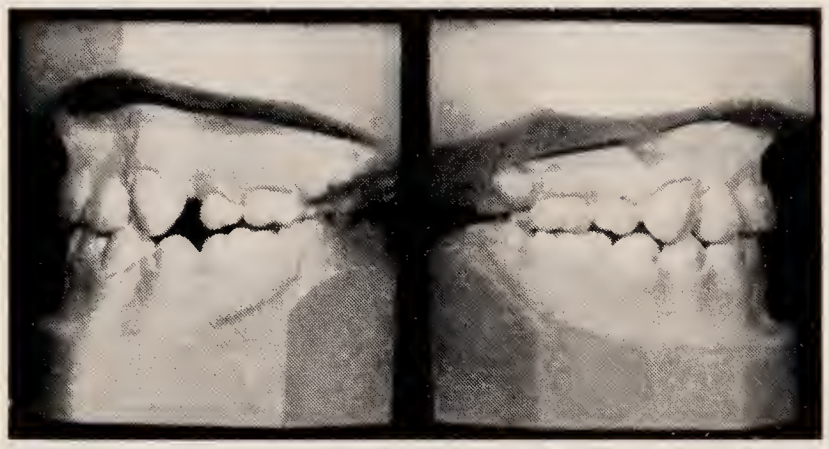


Fig. 4.—Lateral views of study of models after eight months' treatment, August, 1956.

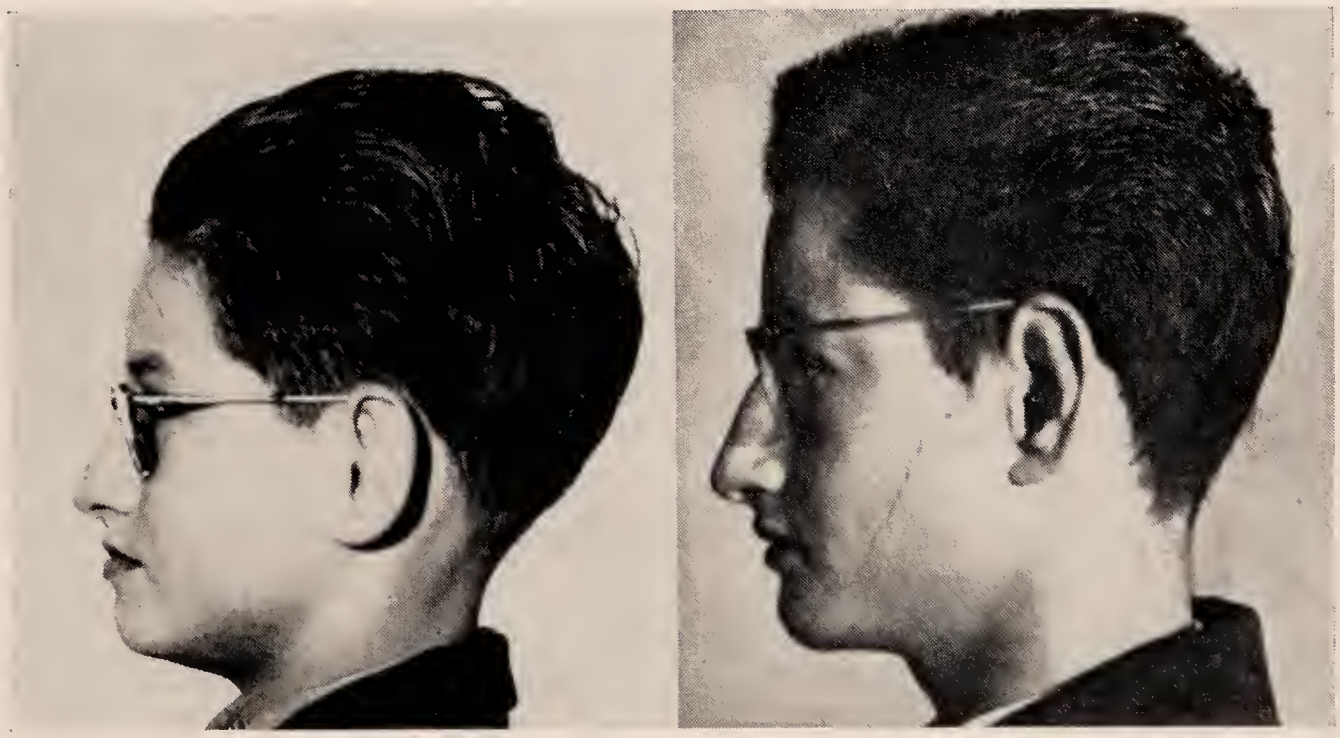


Fig. 5.—Before and after treatment profile photographs.

In June, 1956, a new upper removable appliance was fitted to continue proclination of the upper incisors (*Fig.* 3 B) and then, in July, as the lower left canine was retracted sufficiently, the lower incisors were banded

In August, eight months after treatment was started, the upper incisors were labial to the lower incisors (*Fig.* 4).

This was the end of the active treatment phase during which the lower incisors were

lingually inclined 7° from 87° to 80° and the upper incisors proclined 11° from 118° to 129° (*Table I*). There was a residual space of about 2 mm. distal to the upper left canine and a

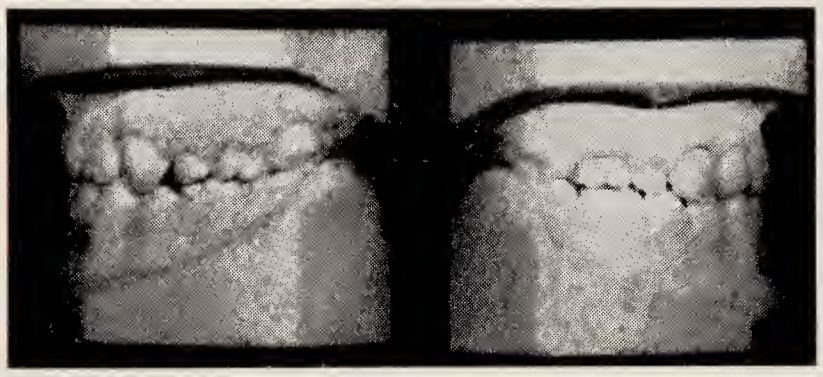


Fig. 6.—Lateral views of study models, November, 1958.

small space (approximately 1 mm.) between the upper central incisors.

In the following month, September, as the upper incisors were held by the occlusion the

Table I.—Tracing Figures before, during, and after Treatment

	Nov. 1953	Dec. 1955	Aug. 1956	Nov. 1957	Nov. 1958
Upper incisors to maxillary plane.	121	118	129	125	125
Lower incisors to mandibular plane	87	87	80	77	76
Maxillary to mandibular plane angle	20	20	20	19	19
SNA	79	80	79·5	81	82
SNB	83	84	83	83	83·5
Difference	—4	—4	—3·5	—2	—1·5

upper appliance was discontinued and the lower bands removed and a lower removable retainer was fitted.

The following year, in June, 1957, the lower retainer was discontinued. It will be seen from *Table I* that in November, 1957, the upper incisor–maxillary plane angle had reduced by 4° (129°–125°) and that the lower incisor–mandibular plane angle had reduced by 3° (80°–77°) since active treatment ceased.

The patient was last seen in November, 1958, when no retainer had been worn for seventeen months.

The before and after profile photographs (*Fig.* 5) reveal a marked improvement in profile. He had an acceptable occlusion and the upper incisors were clinically firm, suggesting that there was no occlusal trauma. The space distal to the upper left canine closed without treatment (*Fig.* 6).

OBSERVATIONS

1. This young boy had a short maxillary apical base. This was revealed by the upper second molars erupting in a buccal position and with a marked distal tilt. On the lateral skull radiographs it appears as though the teeth distal to the first permanent molars are piled one on top of the other.

2. Since this case was a true Class III malocclusion, and was not a postural case, treatment by simply proclining the upper incisors over the lowers without extractions was contra-indicated. The danger in that procedure is the probable production of a traumatic incisor relationship with subsequent resorption of the upper incisor apices and perhaps temporo-mandibular joint trouble later.

The aim of treatment was to tilt the lower incisors lingually as much as the upper incisors were proclined.

The final result in this case showed that the upper incisors had been tilted labially 7° (from 118° to 125°) and the lower incisors tilted lingually 11° (from 87° to 76°) (*Table I*).

3. Study of the SNA–SNB angles shows that before treatment the difference was —4°, indicating that SNB was greater than SNA. When the upper incisors were placed in labial relation to the lower incisors, as the result of treatment (August, 1956), the SNA–SNB difference was —3·5°. This indicates that the normal labial segment relationship was achieved by change in the dento-alveolar structures and that there was very little, if any, postural element in the original condition. If the mandible had been postured forward one would expect to see a change in the SNA–SNB difference immediately that treatment had established the normal incisor relationship.

Similarly, study of the maxillary to mandibular plane angle shows that there was very little change in the before and after treatment values, indicating that this case was not complicated by overclosure.

4. In this case delay in starting active treatment was rewarded by a good result which only entailed eight months' active treatment. If treatment had been started when the patient was first seen, the appliance therapy would have been spread over a much longer period and the case management would have been much more involved.

Acknowledgements.—I am grateful to Mr. S. Granger McCallin, Consultant to the Eastman Dental Hospital, for his permission to publish this case and for his help in preparing it for publication; and to Mr. W. J. Morgan, A.R.P.S., for his work on the slides and photographs.

DISCUSSION

The Chairman thanked Mr. Gould and said he knew only too well what a lot of hard work went into collecting material for case reports. Perhaps he would give a little more information concerning the muscle behaviour in this case?

Mr. Gould said in reply that in the original diagnosis he noted that the soft tissue patterns were normal, so it would not have affected the treatment.

Mr. H. G. Watkin thanked Mr. Gould for the paper and said he wondered whether it was really a Class III case. It seemed to be Class I, and that was why there was such a good result.

Mr. Gould said there was a Class III dental base relationship. It was discovered from the radiographs that the upper incisors were relatively proclined and the lower incisors were relatively retroclined, which meant the uppers were leaning forward and the lowers were leaning back, and yet the lower incisors still occluded in front of the upper. The molar relationship was slightly complicated because there had been movement of the molars due to early loss. Therefore, the molars themselves were not a true indication. But if one examined the canines one found they were in a Class III relationship.

Mr. H. E. Wilson thanked Mr. Gould and said he would like to have one point put clearly and in simple language. Did the author believe he had altered the dental base relationship?

Mr. Gould said that he did not really say that. But there had been a change in the SNA–SNB points; there was no doubt about that. The SNA–SNB points were on the alveolar structures and so it was possible to change them. There might have been some improvement in the dental base relationship, not due to his own efforts but due to nature.

The Chairman then thanked Mr. Gould.

BRAINS TRUST

The President, introducing the members, said that they had been chosen for their wide interests and their wide topographical representation: Professor Ballard was Professor of Orthodontics at the University of London; Dr. Russell Logan, Consultant to the South-eastern Scottish Regional Board; Mr. Peter Burke, Consultant, Newcastle United Teaching Hospitals; Dr. Dockrell, from Dublin and Cork. There was no truth in the rumour that the team had been sitting up all night with their year-books on dentistry.

Question 1: "In an official letter it was stated that the essence of treatment by the Andresen appliance is to move the upper buccal teeth distally. Do the panel agree?"

Dr. Russell Logan said he was the most unsuitable person to answer the question because he did not understand the implications. Where planes were cut in certain cases there were little shiny marks showing that the planes were bearing on the teeth. But they had all seen cases where an apparatus was inserted and, for some reason, it was not possible to cut the planes. In spite of that, reduction of a disto-occlusion had taken place.

Mr. Dockrell said he used the appliances: sometimes they worked and sometimes they did not. He did not know what determined the difference in response.

Mr. Burke: With reference to the Andresen appliance he preferred to use it for the treatment of uncrowded Angle's Class II, division 1 malocclusions in the mixed dentition where the lower incisors were not already proclined. It appeared to work by a form of intermaxillary traction. When a protrusive bite was taken the mandible was displaced forwards. Some patients, if asked about it, mentioned a little stiffness at the angle of the mandible in the mornings and it was in those patients that a good result was obtained. The mandible liked to stay in the rest position. When a muscle is stretched it responds reflexly by contracting, so that when the mandible was displaced anteriorly by the Andresen appliance those muscles which were being stretched would contract. They would therefore be exerting pressure to pull the mandible back to its rest position. This pressure was transmitted through the lower teeth to the Andresen appliance, and hence exerted distal pressure on all upper teeth. The reaction to this force was exerted by the Andresen appliance in the form of mesial pressure on the lower teeth. One therefore proclined lower incisors as the whole of the lower arch came forward and the whole of the upper arch was retracted. He had seen on those few cases for which he had cephalometric records evidence of proclination of mandibular incisors.

Professor Ballard believed that there was further evidence to support Mr. Burke's view. If an analysis were made, both with and without an appliance, one found a continual activity of the retracting muscles of the mandible when the appliance was in the mouth. One should put an appliance in the mouth only after analysing the morphological features and having decided it would produce certain tooth movements. If those movements were not obtained within a month or two one should discard the appliance because the lower arch could be pulled forward. The appliance would move upper buccal segments distally, but there should be plenty of room at the back of the mouth. The procedures of treatment had to be planned just as carefully as when any other kind of appliance was used.

Question 2: "Does the Brains Trust agree that 'One swallow does not make a malocclusion'?"

Professor Ballard said that one swallow did not make a malocclusion. Presumably the question related to the atypical swallowing behaviour which was attributed to malocclusion. The other morphological features were sometimes even more important. One saw typical tongue thrusts in potentially normal occlusions and the only abnormality was a reduced overbite. It was another factor in association with the atypical behaviour of incompetent lips on the variations of dental base relationship.

Mr. Dockrell believed that Professor Ballard had summed up the position neatly. He would question the importance of certain factors, too. Abnormal swallowing by itself in a potentially normal case would not always cause malocclusion. It would be very useful if somebody would produce an analysis of the frequency of atypical or abnormal swallows with absolutely normal occlusions. There were so many references to the presence of a malocclusion and the association of an atypical swallow. It was glibly assumed that the swallow had caused the malocclusion and never the other way round.

Dr. Russell Logan said that there were two factors, the tongue factor and the lip factor. In cases with a marked Class II jaw relationship, one observed the person who grinned and pulled the corner of her mouth upwards and backwards when she swallowed, and one wondered whether it was possible for her to swallow in any other way. There seemed little doubt in such cases that the lip action did contribute to the malocclusion. But it was not the determining factor at all. It would indeed be interesting to work out the association of abnormal swallows with normal occlusions.

Professor Ballard said that Mr. Dockrell and Dr. Russell Logan were entirely right. Probably those in London had said more about atypical swallows than had other orthodontic centres, and they had to admit that a very high proportion of those cases which five or six years ago they would have labelled as "atypical swallowing behaviour" were in fact cases of adaptive behaviours to other features. What we must try to distinguish between in the future (and it was difficult to do) was the true innate variations of tongue behaviour and the secondary adaptive habits. It could occur with all types of abnormality.

Question 3: "Does the panel believe that the removal of first, second, or third molar in the upper or lower jaw can ease crowding of the front teeth in any considerable way?"

Mr. Burke said the question must be dealt with piece by piece. First, would the removal of the upper first permanent molar relieve incisor crowding? In his experience it might relieve incisor crowding if it were carried out early enough, but as soon as the occlusion was locked, particularly if there were crowding in the canine region, the position would not be relieved to any great extent. In other words, if it were wished to treat anterior crowding by extraction of the upper first permanent molars, one had to be prepared to start treatment immediately to

Held at the Manchester meeting on April 18, 1959.

retract bueeal segments. That applied to a greater extent with the second and third molars. In the lower jaw the extraetion of the first permanent molar would, in general, relieve anterior erowding, provided the oeclusion was not loeked.

Dr. Russell Logan said that it was neecssary to decide in the first instanee whether there was an element of erowding present or not. The erowding element aeeounted for probably one-third of their troubles in orthodontics, and for some reason it had never proved an attraetive study to their more seientifieally minded brethren. The first question was whether there was going to be enough room on the jaw for the eomplete dentition of the size whieh was present. If there was an element of erowding present and molars were taken out there would be produeed, in the upper jaw partieularly, spaeing in the front of the mouth. If there was not a erowding element present all that would be produeed was a gap.

In the lower areh it was doubtful whether relief of erowding in the ineisor region would be obtained by extraetion of a lower first molar, even if there was a slight elcment of erowding present. If there was no element of erowding present at all, as happened in eases where the tecth were very small or in Class III eases where there was gapping, there would, of course, be no relief. The question was related strietly to the diagnosis as to whether or not there was a erowding element present in the dentition. If there was, one would get spaee in the front, in the upper jaw partieularly. It might oeeur in the lower jaw, but that was not so likely.

Professor Ballard said that if upper first permanent molars were removed there was less likelihood of relief of eanine lateral crowding in the upper than in the lower, beeause the upper sevens' forward movement was so quiek that spaee might not be gained. In the lower jaw, on the other haud, the movement was not so quiek.

Mr. Dockrell said he presumed the questioner had in mind an established erowding in the incisors rather than intereeptive treatment for an ultimate erowding. It was less a matter of diagnosis than what Professor Radden had the previous evening ealled "predietion". It was established that there was a tendeney for the lower ineisors to straighten, anyway, during the mixed dentition period, and that must be separated from any effeet due to the extraetion of the lower molars. In Ireland he saw a number of eases that had lost four first permanent molars very early. He did not give automatie treatment, but kept them on a very short string and kept wateh. The majority of eases ended with applianees, but there was oeeasionally a satisfaetory straightening out.

The President said he was sure Mr. Dockrell's experienee was not eonfined to Dublin. They all eneountered it frequently.

Mr. Burke said he had nothing to add.

Dr. Russell Logan said that, as with all orthodontie questions, the answer was: "They do and they don't." There were so many faetors to take into aeeount, apart from mere erowding. They must eonsider the relation of the lower base to the upper. The most vital thing was the timing of the extraetion, whieh greatly influeneed the result.

Question 4: "Does the Brains Trust eonsider orthodontic treatment for æsthetie reasons only, a legitimate use of National Health Service money?"

Mr. Burke asked whether one eould earry out æsthetic orthodontie work without improving funetion. Mr. Diekson had summarized the answer in his book by saying that the aims of treatment should be stability, function, æstheties in that order. If it were not for the desire for æsthetic treatment the Soeiety would be a lot smaller than it was and one must put æstheties very high in eonsidering aims of treatment. But one had to bear in mind the other two factors at the same time before expending publie money.

Professor Ballard said he had no hesitation in saying that money should be spent on orthodontie treatment whieh was purely æsthetie. Instead of using the word "stability", he would suggest "harmony". They were reducing the maloeelusion. In many eases they were not able to take teeth to the position of Class I oeelusion, but they were putting them more in harmony with the features of the individual and obtaining results that were æsthetieally more satisfaetory. A reeent paper dealt with work done on the rehabilitation of reform sehool ehildren. There was eonsiderable sueeess as a result of straightening noses and euring squints and removing nævi and other deformities. The ehildren responded very satisfaetorily to æsthetie operations. Orthodontics was in the same field and embraced the mental well-being of the individual.

Dr. Russell Logan said he believed that the Ministry's poliey was that the degree of mental fitness whieh it was their duty to provide was that which was neeessary for the maintenanee of general health. For some ehildren maloeelusion was definitely upsetting mental development. Some girls eomplained that their friends called them "Buek-teeth". However, one sometimes wondered whether some of the more theoretical "issues" were properly eharged against publie money.

Mr. Dockrell said that Ireland was not so concerned with the question. One of their main grounds for treatment was æsthetie and he knew of no evidenee that there was an assoeiation between maloeelusion and caries or periodontal disease whieh justified the automatie treatment of the malocelusion. He did believe the treatment of maloeelusion for æsthetie reasons benefited a patient psyehologieally and that this amply justifiед the treatment.

Professor Ballard said they were not spending other people's money through the National Health Serviee; they were spending their own money, and they must think very earefully about the way they spent it.

Question 5: "To what extent, if any, does the panel think that soft-tissue aetivities can be modified by orthodontic treatment?"

Dr. Russell Logan said he kept wondering why orthodontists eould not speak plain English. What was "soft-tissue aetivity"? Was it the behaviour of the soft tissue?

Mr. Dockrell said that the people in Ireland were lueky in that they did not have soft tissues.

Mr. Burke said that Mr. Doekrell was probably quite right. There was either more soft-tissue aetivity around London or perhaps there was more aeuity in the deteetion of this aetivity. Certainly in potentially eompetent lips with teeth resting between upper and lower lips if the teeth were retraeted the lip posture was more satisfaetory. In other types of mildly incompetent lips he sometimes used oral screens and thought that they improved lip posture. It might be a question of maturation of lip behaviour and that was really what was improving lip posture.

Professor Ballard said they were now getting a elearer pieture of soft-tissue faetors. The pieture emerging was that basieally there were patterns of posture and patterns of behaviour arising from the eentral nervous system,

probably as a result of inherited factors, and superimposed on those patterns were adaptive patterns—habit postures and habit activities adapted to the other factors that were inherited. The adaptive postures modified themselves. He did not like the suggestion that some of the changes were what they had in the past called "maturation". Careful study would indicate there was not a change in basic characters of individuals as a result of maturation.

Mr. Dockrell said it must be correct to assume there were genetic patterns and that superimposed on them were bound to be adaptive changes. What interested him was the sensible question posed the previous day: How was one to know beforehand? They were inclined to say that a change was adaptive and then, if it did not alter, to say that it was inherited.

Dr. Russell Logan said that he could not believe that queer habits of use of the soft tissues did not disappear as a result of a child growing up. Quite a large number of children at the age of 5 years showed queer lip movements; a smaller proportion of adults showed them. Children grew out of these habits.

Question 6: "What are the Brains Trust's views on the actual cause of the pain associated with the so-called Costen's syndrome?"

Dr. Russell Logan said the pain was probably caused by spasm in the muscles of mastication operating in an environment which was unfavourable to their normal life and operation. The bony parts to which they were attached had altered their shape and their relationship one to another, and the muscles were in a continual state of partial spasm. Possibly the lower jaw altered its position.

Mr. Burke said that the kind of cases he had seen were Angle's Cl. II, div. 1 or div. 2 malocclusions on post-normal base relationships with excessive anterior overbites. Temporary relief could be obtained by the local surface application of ethyl chloride, which stopped the pain and suggested that the pain was due to muscle spasm. Orthodontic treatment to reduce the excessive anterior overbite could be of help to these patients. He was not in favour of a permanent bite-raising appliance in the form of occlusal caps on cheek teeth only, although this would give temporary relief of pain.

Professor Ballard said that there was overwhelming evidence to suggest that the pain was in the muscle, and recognition of this was rather important. The people treating Costen's syndrome did so by functional analysis and the treatment of disturbed mandibular activity and they got quick relief of pain. The oral surgeons who did not know anything about functional analysis took out condyles, but admitted they could not see any cause of pain in the joint.

Mr. Dockrell said that he agreed.

Question 7: "The floor of the nose of a child is smaller than an adult's. It is reasonable to assume that there is lateral expansion in the molar region at the apical base. Do expansion plates assist that growth and thereby increase the width of the apical base?"

Mr. Burke said that there were two types of lateral expansion; in the first expansion was carried out at the normal rate, and in the second the rate of expansion was very rapid. The latter was called "dysjunction" and apparently parted the two halves of the maxilla. He had no experience of this type of expansion. In the literature one could find a case history in which three expansion screws were used in rapid succession. When the molar teeth were palpated it was noticed that the central incisor on the same side also moved. There was no delay in placing this case into retention. Some work was now being done on the Continent using "dysjunction" to disconnect the vomer before repositioning of segments in the early treatment of the cleft palate patient.

In his opinion an expansion plate used at the normal rate did not increase the width of the apical base. The main growth vectors of the face were downwards and forwards. The growth of the dental bases was more or less fixed in its lateral dimensions from a fairly early age. The only area in which the lateral dimension of the bases increased was posteriorly as the dental base extended posterolaterally to accommodate the molar teeth. The lateral dimensions of the arch remained reasonably stable, excepting the intercanine increase occurring at the time of eruption of the incisor teeth. This varied from child to child, with a mean of about 2 mm. in the upper arch. It might be reasonable to anticipate that expansion and help it on its way with a midline expansion plate, but he did not use lateral expansion for this purpose.

Mr. Dockrell said that he, for one, used it. Perhaps people in Dublin were very old-fashioned. There were two problems. One was springing, which lateral expansion plates could do quite frequently. If they were cut well away from the incisors and allowed to act on the cheek teeth it was found that the incisors splayed. At the age when they were used there was little lateral growth going on, and the width in the first molar region was a very stable dimension, although occasionally it was found to drop or rise a little.

Professor Ballard said he would rather not get involved with this question. He did not think one could permanently expand. The people who were trying to do it were those who believed that a constricted nasal airway could result in lack of oxygen for the individual and flat-feet!

Dr. Russell Logan said the lateral wall could move outwards without any effect on the apical base at all. As to whether expansion plates assisted growth and thereby increased the width of the apical base, he did not think they did. The inter-molar width increased in some children without treatment, while in others it did not. In some cases it might diminish.

He was once privileged to have as a patient a little girl with marked bimaxillary crowding. She had a French mother. Her teeth were crowded in both the upper and lower arches. He was proposing certain treatment when the child suddenly went home to France.

The upper arch was expanded about 3·5 or 4 mm. and the child still had a lower incisor crowding. Over the following three months the lower arch also expanded, and it was interesting to observe the improvement in the incisor crowding, though it was doubtful whether it would be maintained. He was unfortunately prevented from following the case further.

The President said that the Brains Trust had had to put up with a great deal and their job was not a light one. There was always a certain amount of mischievous glee in watching the examiners being examined, but the panel had managed to answer the questions concisely with both sparkle and humour. The session had been interesting and unfortunately could not be prolonged. He thanked all those who had submitted questions, and apologized to those whose questions had not been dealt with. They would all want to indicate their appreciation of the panel, who had stood up to their ordeal so well. (*Applause.*)

THE ORTHODONTIC TREATMENT OF A SET OF UNIOVULAR QUADRUPLETS

By **JOHN C. RITCHIE**, L.D.S. R.C.S. (Eng.)
Westminster Children's Hospital, London

QUADRUPLETS were born in the Westminster Hospital, London, on the night of Sept. 12, 1950. There are reports which suggest that cases of quadruplets are tending to increase, but the rate remains at approximately the cube of the figure for twin pregnancies, i.e., 1 in 600,000 births. As distinct from this, uniovular quadruplets are extremely rare.

There are now five surviving sets of 'quads' in Britain, and the Westminster set is the only example of uniovular quadruplets. The babies were all girls.

The mother already had one son born in 1945. She was a healthy looking, well-nourished woman aged 27 years. Her pregnancy proceeded normally for five months, when she began to show some œdema of ankles and hands. It was found that rest produced an improvement in this condition.

At the end of six months many fœtal parts could be palpated, and approximately one month later the presence of quadruplets was confirmed by X-ray examination.

The patient was then admitted to the Westminster Hospital in view of the œdema of the lower limbs, which subsided with rest in bed.

Special arrangements were made, to be put into operation immediately labour commenced: these included special incubators to be provided by Oxygenaire Ltd., and they were installed in a prepared premature infant room.

On Sept. 12, 1950, 20½ hours after the spontaneous rupture of the membranes, labour commenced, and this was uncomplicated and rapid.

The duration of labour was 3 hr. and 38 min. and all the babies were delivered normally, the times between the births being 14 min., 29 min. and 3 min.

The placenta was a large single structure, with only one cord, the other three being velamentous in type. It was proved both macroscopically and histologically that all four sacs consisted of amnion only, the whole lot being contained by a single chorion and therefore associated with a common placenta—that is, the quadruplets were uniovular.

Blood-testing of the infants and their parents showed the following results:—

	Group		
"M"	A	Rhesus positive	R_1R_2 CDe/cDE
"E"	A	Rhesus positive	R_1R_2 CDe/cDE
"P"	A	Rhesus positive	R_1R_2 CDe/cDE
"F"	A	Rhesus positive	R_1R_2 CDe/cDE
Father	A	Rhesus positive	R_1R_1 CDe/CDe
Mother	O	Rhesus positive	R_2R_2 cDE/cDE
Brother	A	Rhesus positive	R_1R_2 CDe/cDE

Dr. Mourant, of the Lister Institute, has further studied the blood groups of these children, including the M. N. Lutheran and Lewis Kell groups.

All the subgroups are identical in the four quadruplets.

From birth the children came under the care of the Pædiatric Department. Their average weight at birth was 3 lb. 7 oz. They were nursed in Oxygenaire incubators and the oxygen supply was reduced on the 28th day, with air supply only after the 35th day.

They were tube fed with expressed breast milk, up to 5 drachms of three-quarter strength, given 3-hourly.

After the fourteenth day full-strength expressed breast milk was given and by the 32nd day bottle feeding was instituted.

When discharged from hospital on the 69th day each child had doubled her birth weight.

There were no complications after leaving hospital and all the children grew steadily and well.

Given at the Manchester meeting held on April 18, 1959.

They were housed in a large flat in Westminster, where they have continued to live as a very happy family.

These children did not come to my department until they were 5 yr. 11 mth. old and they were then referred for an opinion about their orthodontic condition by the dental surgeon who had been responsible for their conservative treatment. It had to be regretted that each child had already lost both second lower temporary molar teeth and a considerable amount of conservative work had been done.

Fig. 1.—Photograph of the quadruplets before treatment was commenced. Age 5 yr. 11 mth.

The mother was questioned very closely about the children's diet and also about their dental hygiene and it was discovered that there were considerable faults in both these important fields. They were eating far too much starchy food and sugars and not nearly enough protein foods, with vegetables and fruit at a minimal level.

New dietetic factors were explained to the mother and she was most helpful, in that she complied in every detail with regard to a change of diet.

The toothbrush had been used only spasmodically, and as is so often the case, the children had often gone to bed with the remains of milk and biscuits on their teeth.

This, of course, had to be altered and a strict oral hygiene routine established. The mother was very diligent in this matter also, and although she had some difficulty to begin with, she succeeded in a matter of weeks in getting the children to clean their teeth after every meal. An alkaline toothpaste was advised and the children liked the flavour, so all was well.

Fig. 2.—Palm print of "E". Angle at axial triradius equals 70°.

The mother has always maintained that her four children are two sets of twins, because in appearance and temperament that appears to be the case, and although from the medical evidence this cannot be so there are certain factors which emerge to make the mother's contention seem reasonable.

It can be seen (*Fig.* 1) that there is a similar appearance of "M" and "E" and also of "P" and "F". The former are thinner faced, brighter, and more intelligent children, the crowns of their heads are on the left side and their forehead curls both turn to the right.

The latter pair are also similar in appearance and nature. They are larger in head and body and slower in intellect. They both have double crowns, one with forehead curls left and the other right.

Their fingerprints, as one would expect, are all different, although they do show certain similarities.

The palm prints of these children are most interesting when the triradiation angles made by the crests are analysed (*Fig.* 2). There are on every hand three of these angles formed by the junction of the crest lines, one at the base of the hand near the wrist and the other two widely spaced immediately below the fingers.

The points made by these triradiation angles now have to be joined up by straight lines, and it is the angle at the base of the hand in which we are interested. In "P" and "M" these angles are equal at 47°, being found fairly low down near the wrist, but in "F" and "E" the position of the angle is much higher and the angles themselves are 55° and 70° respectively.

Now it is known that in a Mongol child this base angle exceeds 45° and the position of the axial triradius is found more than 40 per cent up the length of the hand, measuring from the distal wrist crease at the base to the proximal crease of the middle finger, superiorly.

It is also noticeable that the fifth digit is short in all these children. Instead of reaching the superior crease on the ring finger, the fifth digit falls short by over $\frac{1}{4}$ in. This is due to a lack of normal development in the middle phalanx and is another diagnostic feature.

All four children have hallucal patterns on the soles of their left feet, which are loop distal, with a ridge count of under 21 (*Fig.* 3). This pattern occurs in 33 per cent of Mongols, as compared with 9·6 per cent of normals.

There are other factors, such as ulnar and radial loops and whorls, but greater detail on these matters should be avoided in this paper.

All four children were brought to the Orthodontic Department by their mother, and it was obviously going to be a most difficult task to differentiate between these children until it was realized that some wise person had sewn the children's initials on their caps and pullovers.

A record card was made out for each child, and once the cases had been assessed, a provisional diagnosis was made.

Impressions for clinical models were taken and lateral skull radiographs and photographs were produced.

The details were then carefully considered, and, although each case was slightly different, the prenormal position of the mandible in

Fig. 3.—Calcar mound. Sole of left foot "M" showing hallucal pattern, loop distal.

three of the children was very similar in each case. The fourth child presented a crossed bite to the left and, although differing from the others, her condition can be considered to have originated in the same way.

The mother was quite emphatic that the prenormal position of the mandible was not brought about by the removal of the two temporary second lower molar teeth and this was borne out by the dental surgeon who extracted these teeth.

The mother said that the prenormal condition had not always been present, but was noticed first when the children were about 2 years old.

This bears out my earlier reports on this form of abnormality, which appears to occur when the temporary canine teeth erupt,

between the ages of 18 months and 2 years. In most cases the incisor teeth and the first temporary molars are in normal relationship, when, for some reason, the temporary canine

father's side of the family, so there is a history, and indeed present evidence, of a Class III relationship in the father's dentition. As distinct from this, the mother has a normal

A B

C D

Fig. 4.—A, Photograph of "F" before treatment. B, Photograph of "F" after treatment. Note growth in the middle third of the face and improvement in appearance of nose, upper lip, and red margin. C, Class III relationship before treatment, "F". Identical condition present in "E" and "P". Age 5 years 11 months. D, Incisor relationship after treatment, "F". Identical result obtained in the case of "E" and "P". Age 7 yr. 2 mth.

teeth erupt cusp to cusp, giving a bite of two-point contact only.

This is a position of no comfort for rest or mastication, and the mandible therefore slides forward or to the left or to the right and it is almost a matter of chance as to which way it does move.

In the same way that there is a history of twinning, though not a strong one, on the relationship, although she wears a full upper denture now.

All four quadruplets presented a very flat profile, which can be associated with a mild pre-normal mandibular position at 6 years of age.

The lower lip appeared to be everted and pouting in each case.

There was wide setting of the eyes and bridge of the nose.

The wide setting of the eyes or ocular hypertelorism (*Figs.* 4, 5) has been noticed in many cleft palate patients, and clefts of lip and palate appear to be more prevalent in families with a history of twinning and club-foot.

This craniofacial deformity is associated with undue separation of the orbits and is primarily due to abnormal development of the sphenoid bone during the early fœtal life and is connected with a disturbance in the function of the pituitary gland.

Three of the children have a prenormal occlusion with mandible centric (*Fig.* 4 C). The fourth child has a crossed-bite on the left side and although the mandible is only about $\frac{1}{8}$ in. out of centric in the tooth position, the full face shows a considerable deviation of the chin to the left (*Fig.* 5 A).

A condition of this kind can often go unnoticed by parents, and if left beyond 7 years of age can have serious effects on the temporomandibular joint and the growth centre in that area.

A B C D

Fig. 5.—A, Photograph of "M" before treatment, showing deviation of the chin to the left. B, Photograph of "M" after treatment. Note growth in the middle third of the face and improvement in the appearance of the nose, upper lip, and red margin. C, Crossed-bite before treatment, "M". Age 5 yr. 11 mth. D, Incisor relationship after treatment, "M". Mandible now in centric occlusion. Age 7 yr. 2 mth.

TREATMENT

The orthodontic treatment to be described was essentially simple in character; in fact, simple treatment instituted just at the correct time is the criterion of success in many of our orthodontic cases.

It would have been preferable, however, if these children had been seen some two years earlier at 3 yr. 11 mth., instead of at 5 yr. 11 mth., because the sooner in life that the prenormal mandible is controlled in its forward growth, the greater is the chance of ultimate success, without relapse.

At the earlier age, all the temporary incisor teeth would still have been firm, but these quadruplets were fortunately just a little late in shedding their upper and lower temporary incisors.

The treatment plan for these children was to obtain an upper incisor overlap and overjet at the earliest opportunity and hence put some natural restraining influence on the forward unrestricted mandibular growth.

A removable appliance was used in each case.

The bite was opened on occlusal bite platforms cast in "B" metal, thus allowing the mandible free and uninterrupted movement.

The upper labial segment of six anterior temporary teeth was carried forward by means of a Glen Ross expansion screw, embedded in the anterior part of the palate of the appliance. Retention was by means of modified Adams's cribs posteriorly and plain cribs anteriorly.

It was noticed almost immediately that the mandibular teeth could bite into an edge-to-edge position with the uppers and invariably did so when the mandible was given freedom of movement. In other words, the habit of the muscles controlling mandibular movement had not yet become sufficiently estalished to hold the mandible permanently forward.

The labial segment in the upper was moved slowly forward over a period of six months until a reasonably stable incisor relationship was reached. This was done by opening the screw one turn each week, and the temporary upper incisors and canine teeth and the bone supporting these teeth were moved forward between 4 and 5 mm.

It was then found to be necessary to expand the upper arches laterally for a short length of time, because although the antero-posterior relationship was much improved, it appeared that the temporary lower canines and first molars could not quite bite inside their opponents in the maxilla.

Although the treatment had been identical for each child, "E" and "M" were in a better relationship than "P" and "F".

It was decided now to await the eruption of the permanent central teeth in the upper and lower jaws.

Everything appeared to be proceeding normally, with the new teeth erupting, when the children became ill at this time of crisis in my treatment plan.

The mother came to tell me that in the case of "E" and "M", who were a little earlier with their new teeth, the upper central teeth had erupted anterior to the lower central teeth and all was well, but with "P" and "F" it looked as if the upper central incisors were going to erupt inside the lowers, and she wanted my advice.

While they were recovering from their illness, they were seen again, and it was found that the mother's assessment had been absolutely correct, but it was thought wiser not to contemplate making new appliances until the children were completely fit.

Wooden spatulas were therefore to be used after each meal, and for a period of five minutes on each occasion. The spatula was placed under the upper central teeth and pressure applied to the inner surface with the lower incisor teeth. The correct relationship was achieved in a very short space of time.

An upper incisor overlap and overjet had been obtained in the permanent dentition some 15 months after active treatment had been instituted and completed in the temporary dentition (*Figs.* 4, 5).

It is now reasonable to assume that the prenormality of the mandible will not recur, although a regular watch will be kept upon these children, until they have completed their growth.

The loss of spaee as a result of the premature extraetion of the seeond temporary lower molars was very small indeed, and this is a notieeable faetor in many eases of Angle's Class III abnormalities, when sometimes the spaee may even open.

It may be neeessary at a later stage to remove a premolar tooth symmetrieally in the partieular ease, and what has taken plaee naturally.

Models tell him a eertain amount, but not nearly so mueh as superimposed traeings of eephalometrie lateral skull radiographs (*Fig.* 6).

These traeings of the quadruplets are superimposed on a Registration point, R. The Bolton plane must first be drawn. This is from

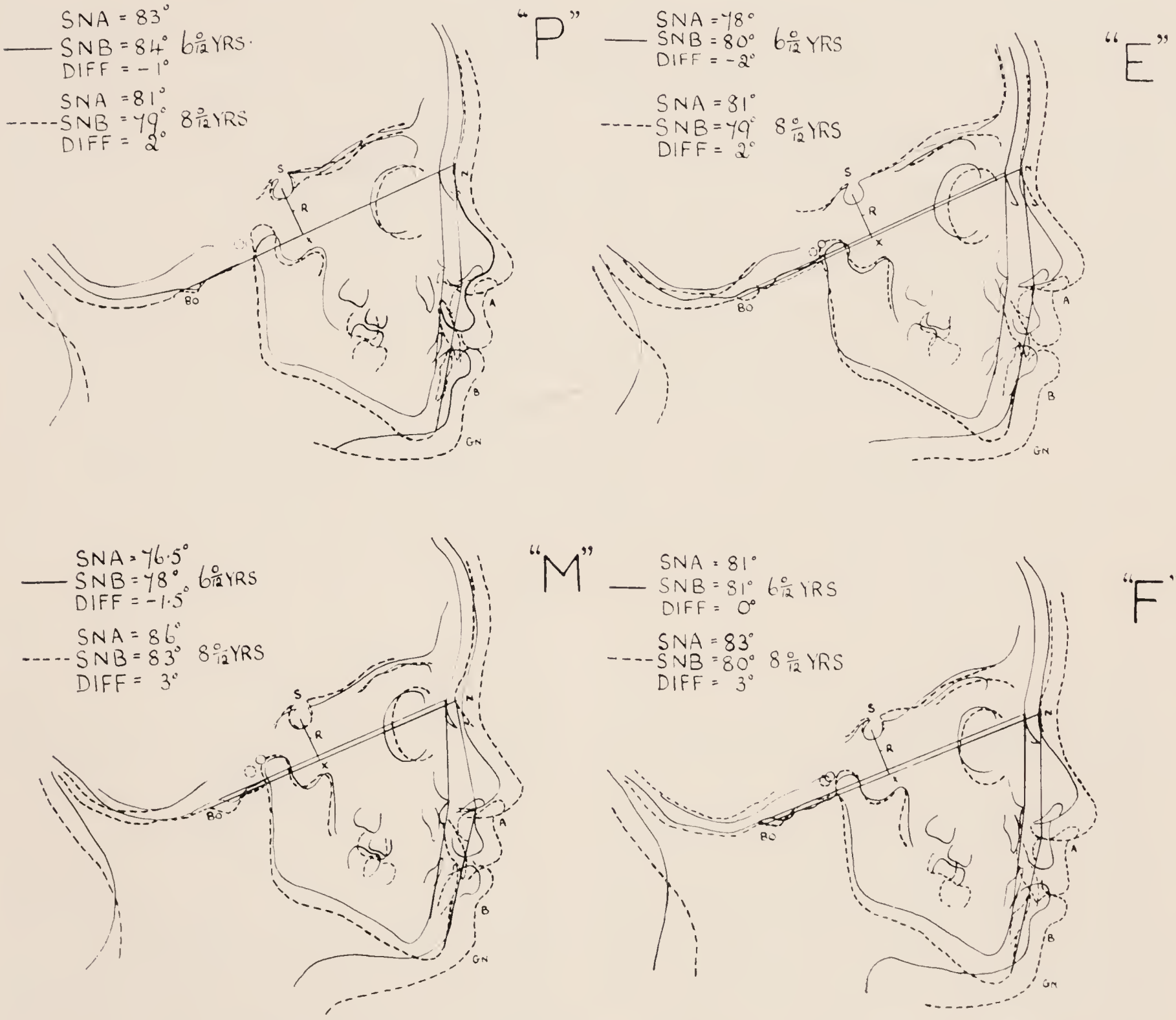


Fig. 6.—Superimposed tracings of lateral skull radiographs of all the "quads" before and after treatment.

lower jaw in view of the original Class III relationship, and also to obviate the risk of impaeted mandibular third molars, but this is by no means eertain at the present time.

A great deal may be learned in the orthodontie field if the practitioner will look baek and try to assess what he has aehieved in any

Bolton point, BO, to Nasion, N. A perpendieular is then dropped from Sella Tureiea to the Bolton plane, and R is the eentre point of this perpendieular line.

In this two-year growth period under eonsideration (*Table I*) it is interesting to note that the three ehildren who presented a prenormal

mandibular relationship in a centric position have all grown by amounts which are almost identical as far as measurements of the skull are concerned. The child "M", who had a crossed bite, is somewhat smaller in each measurement made.

The angle of the upper incisor to the Frankfort plane has been increased in the three children "E", "P", and "F" by 9° or 10°, but it is most interesting to note that the angle of the lower incisor to the mandibular plane with no forces exerted upon it has been

Table I.—Measurements of Facial Growth in Three Directions during the Period under Discussion

	Distance R to Incisal Edge 1|		Difference	Distance N–GN		Difference	Distance X–N		Difference
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
"M"	69	89	20	103	110	7	59	63	4
"E"	71	93	22	104	116	12	63	70	7
"P"	72	94	22	104	116	12	63	70	7
"F"	71	93	22	103	115	12	63	70	7

Table II.—Changes in the Facial Profile and Incisor Tooth Angulation which occurred as the Result of Treatment

	Angle of Facial Profile		Difference	Angle of Upper Incisor to Frankfort Plane		Difference	Angle of Lower Incisor to Mandibular Plane		Difference
"M"	168°	159°	−9°	104°	107°	3°	93°	86°	− 7°
"E"	170°	162°	−8°	101°	110°	9°	92°	80°	−12°
"P"	172°	164°	−8°	100°	109°	9°	88°	76°	−12°
"F"	174°	166°	−8°	100°	110°	10°	87°	76°	−11°

In each case, the first measurement is before treatment and the second measurement after treatment.

The growth in the total face height, Nasion to Gnathion, N–GN, in "E", "P", and "F" was 12 mm., while in "M" it was only 7 mm.

The forward growth of the superior face from point X to Nasion, X–N, had increased by 7 mm. in the three children, and only 4 mm. in "M".

As a result of treatment, the differences between the angles S N A and S N B before and afterwards are significant (*Fig.* 6), and this is borne out by the reduction in the angle of facial profile or facial convexity (*Table II*).

In this case the angle is made at the anterior nasal spine by intersecting lines drawn from nasion and from the most anterior point of the mandible in the midline.

reduced by 11° or 12° to some 76–80°, which appears to be an acceptable position both functionally and aesthetically.

CONCLUSIONS

It has been my experience to watch many Class III abnormalities arising in the temporary dentition of very small children.

My work in a Children's Hospital where the patients are normally seen from birth to 12 years of age may seem, to the established orthodontist, a rather unusual approach to a subject which many consider to be better left until a child is much older.

However, a great deal may be learned from these very small children, particularly with regard to the development of abnormalities which the average orthodontist never sees.

A careful watch has been kept to discover any Class III relationship which may be present before the temporary canine teeth erupt, and not one case has been found in the period of the last eight years. In the same period, however, 75 cases of Class III deformity have been treated in the temporary dentition with very successful results. Once an incisor overlap has been observed in the permanent dentition, no further prenormality of the lower jaw has developed.

This leads me to believe that many of our Class III abnormalities arise in the temporary dentition at the age of 18 months to 2 years owing to the faulty interdigitation of the cusps of the temporary canine teeth. Because of this assumed faulty relationship, the mandibular bone develops at a far greater rate than is normal, and the growth centres in the maxilla are inhibited purely because of the position of the teeth in the upper jaw.

This abnormal bone development continues until adult life, with many of the fearful results which we see and which, in the end, can only be treated by surgical procedures, the most popular of which is the Kostekka operation.

How easy it is, therefore, to deal with these minor abnormalities at an early age, and to save the patient lengthy and complicated treatment in adolescence, at a time when schooling and examinations may play havoc with the best laid treatment plans.

I am indebted to Mr. Arthur Bell for permission to show some of his photographs of this case, and to Mr. Frank Denny for his help in providing details of the early life of these children.

To Chief Superintendent Livings, of Scotland Yard, for the preparation of the palm prints.

To Dr. Sidney Blackman for the preparation of the lateral skull radiographs, and to Dr. Hansell and his staff of the Department of Medical Photography at the Westminster Hospital for the excellent photographs which they have produced for me.

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DISCUSSION

The President thanked the author for a valuable and interesting presentation. They had been enthralled by his observations. It was probably the ambition of every one of them at some time to "collect" twins or triplets or quadruplets. It was a little surprising to hear the word "hypertelorism" used and he would not have thought it applicable. Then, reference was made to a "pendulous lower lip". Mr. Broadway had shown them such a fine example the previous day, but he would not have used that description in any of the quadruplets, judging by the photographs.

Mr. W. J. Tulley congratulated Mr. Ritchie on a most meticulous paper, particularly with regard to the detail of the genetic factors. He had a great regard for Mr. Ritchie's work. He had recently been in charge of a set of quadruplets himself, two of whom were uniovular while the other two were quite dissimilar.

An intriguing aspect of these quadruplets was the differences that had been pointed out. It might be said that the differences were minor ones, but there nevertheless was a difference, particularly in one of the four. Nor could they ignore the mother's attitude about her having two pairs of twins. The hæmatological reports were all adamant that the children were all from one ovum and had the same basic genetic pattern. Did this indicate influences in intra-uterine environment? In multiple births all the children had a similar environment fundamentally, but with four fœtuses being supplied by the maternal circulation there might be minor differences which could account for differences in development.

The author seemed to stress occlusal interference and its effect on growth. He had said that the upper jaw was not developing as rapidly and the lower jaw was developing more rapidly entirely owing to occlusion. Mr. Tulley could not disagree more about that.

One might wish the author had left at least two of the quadruplets alone. It would now never be known how they would have developed had they not been treated in the early stage. The ideal time for treating pseudo-Class III cases was when the permanent incisor erupted. With all respect, the author might have been wasting his time. It was an intriguing suggestion that growth had been enabled to occur more normally. Certainly the alveolar process was influenced, but the effect on mandibular growth was open to question.

The author had said that the lower spaces created by extraction were not closing, which was natural in skeletal III cases, and went on to say that he was contemplating the extraction of two lower premolars. There must be others who would want to ask searching questions. The author had studied the genetic background and that was the key. They wanted to know more about intra-uterine differences with the same basic genetic set-up.

Mr. Ritchie, replying to the President, said he had recently been dealing with a lot of cleft palate children and perhaps hypertelorism was something one looked for rather too closely. The orbit width in these particular

children was very marked, certainly at the early age, but as they were developing it was tending to become less. As for the reference to pendulous lips, the children were quite ugly when first seen. They stuck out their lower lips and chins. Perhaps the photographs shown portrayed them on their best behaviour. However, it was something that should be mentioned in passing in view of the relationship.

Mr. Tulley's remarks were always interesting as a result of his wide experience. Occlusal interference might have been stressed rather too forcibly, but in dealing with very small children one felt as if there were in one's hands such small organisms full of dynamic growth potential, and to see a small child developing was something intriguing. The tissues were so soft and malleable that one experienced a sense of enormous possibilities. Anything put in the way of normal growth could be most disturbing. The question of the extraction of the lower premolars was just a passing fancy and certainly not something rooted in his mind. It was something being thought about for the future.

Mr. G. C. Dickson thanked Mr. Ritchie for a fascinating paper. He had said that the growth centres in the maxilla were inhibited. Just how did he think the maxilla grew?

Mr. Ritchie said the question was difficult. They all knew that the maxilla grew in a forward and downward direction. If there was put in the way of that growth hard tooth tissue, then there probably occurred the same sort of thing which occurred in the cleft palate patient as a result of the interference of surgery. Certainly very early surgical intervention would stop the maxilla from growing normally. Recently he had seen some pictures of twenty-one Mexicans, all adults, who had cleft palates which had never been touched. They had teeth erupting in all sorts of directions, but maxillary growth had occurred quite normally. Anything which was put in the way of normal growth was a disturbing factor.

Mr. A. J. Walpole Day thanked Mr. Ritchie for an enlightening and amusing paper and said he wanted to put four brief questions. Were any of the children left-handed? Had Mr. Tulley's suggestion of not treating two of them been considered? Had Mr. Ritchie considered grinding down the cusps of the temporary canine teeth? Had the children had their tonsils or adenoids taken out or any other surgical interference? As regards the tracing of quadruplet "M", the orbit, instead of descending about 2 mm., actually appeared to have gone up about 2 mm. Was the orientation of the X-ray quite accurate?

Mr. Ritchie said that all the children were right-handed. It would not have been fair to have treated two of the quadruplets and left the other two untreated. The family were so united that it would have been a shame to have done so. There had not been a tremendous amount of success in cutting down the teeth. It produced an edge-to-edge bite, but nothing better than that. It was often necessary to cut quite a lot off the teeth and it did not serve a very useful purpose. The children had undergone no surgery of any kind. With regard to the orbit tracing the point had not been noticed, but he would check up on it.

Mr. H. E. Wilson said that had he been given Mr. Ritchie's glorious opportunity he would have done the same thing. It was easy to criticize other people's work. There were aspects of growth and development which cephalometrics could not explain. It was a wonderful method of appraisal and one learnt a lot from it, but it was not 100 per cent successful.

The children "M" and "E" were very similar but they were not alike in facial measurements. It should be remembered that two children might be quite different although they were twins. One should not read too much into comparisons in growth or treatments. Mr. Ritchie's valuable material might have included some ciné record of the soft-tissue behaviour.

Mr. Ritchie said he agreed that there were considerable differences between the quadruplets "M" and "E". The differences were interesting to observe. One would probably expect to find the children more similar than they actually were. Further investigation would probably reveal many other differences, but there were enoug in the head and the teeth only. He hoped in the future to take advantage of the suggestion to make a cinematograph film of soft-tissue behaviour.

Mr. Tulley said it was the last paragraph of the paper which had really roused him. It suggested that by early treatment one would prevent some of the major Class III jaw relationships and obviate the necessity for operations. That was the one point with which he really disagreed.

The President said the discussion had been an extremely interesting one, which again, could have continued for a long time. He thanked Mr. Ritchie for his careful and valuable presentation.

CONGENITAL PARTIAL AGLOSSIA

By **J. H. GARDINER**, B.D.S., D.Orth. R.C.S.

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As far as can be ascertained, only 10 cases of the condition of congenital absence of the anterior portion of the tongue have been reported from various countries as far back as 1718 (*Table I*). In 5 of the 10 cases reported the absence of the anterior two-thirds of the tongue has been accompanied by other anomalies such as cleft palate or absence of fingers or toes.

DEVELOPMENT

The anterior portion of the tongue begins as an enlargement of the tuberculum impar in the central portion of the mandibular arch at about the fifth week or the 8·5-mm. stage of intra-uterine life. It has been suggested by Sinclair and McKay (1945), in their account of a patient with a similar aglossia, that at about the sixth week of intra-uterine life or at the 12-mm. stage, further development of the tuberculum impar ceased. In the case of their patient, who died 4 weeks after birth, they were able to confirm their suppositions by post-mortem examination; for instance the distribution of the fifth and twelfth

Table I.—Reported Cases of Partial Aglossia

Reporter and Country	Year Published	Age of Patient	Other Anomalies	Similar Conditions in Family	Speech	Taste
Jussieu (France)	1718	9 yr.	Not reported	Not reported	Difficulty with e, f, g, l, n, r, s, t, x, y, and z in French	Normal
Spiller (U.S.A.)	1816	Infant, age not reported	Cleft palate	Not reported	Not reported	Not reported
Kettner (Germany)	1907	Child, age not reported	Cleft palate. All toes and some fingers	Not reported	Difficulty with some consonants	Not reported
Watkin (England)	1924	Child, age not reported	Partial anodontia. Reversal of viscera	Not reported	Difficulty with s, f, and x	Not reported
de Lamothe (France)	1930	Died at 3 wk.	Vertical membrane across mouth	Not reported	—	—
Rosenthal (U.S.A.)	1932	3 yr.	Partial anodontia. Cleft of lower lip. Absence of some fingers and toes	None	Not reported	Not reported
Sinclair and McKay (U.S.A.)	1945	Died at 4 wk.	Hare lip, cleft palate, webbing of fingers and toes	Not reported	—	—
Farrington (U.S.A.)	1947	22 yr.	Vertical fibrous cord in mouth	None	Difficulty with q	Normal
Doekrell (Eire)	1949	4 yr.	Partial anodontia	None	Rather thick	Not reported
Eskew and Shepard (U.S.A.)	1949	22 yr.	None	None	Difficulty with p, b, m, f, v, w, and sh	Soft palate only

Given at the Manchester meeting held on April 17, 1959.

cranial nerves in the tongue of their patient indicated agenesis rather than atrophy of the tongue.

PRESENT CASE

The case presented here was referred at the age of $5\frac{1}{2}$ years from the Speech Therapy Department of the Sheffield Children's Hospital. This child's parents were both in their 30's and were in good health. They could not recall any similar anomaly in either of their families. The patient was delivered at full-term. The birth was uneventful, but her birth weight of $5\frac{1}{2}$ lb. was less than that of her 3 brothers and 3 sisters who were all between 7 and $7\frac{1}{2}$ lb. Shortly after birth it was noticed that she could not suckle and it was then that the absence of a tongue was discovered. The physical anomalies such as cleft-palate or missing digits which accompanied 5 of the 10 other cases reported were not present.

As in Rosenthal's patient (1932) this child was late in walking and in developing generally, for she is smaller even than her sister who is 15 months her junior. When this patient was younger, dry food especially used to collect in the vault of her palate and had to be released with her finger, but she has now learned to correct this and to control the dribbling of saliva at the corners of her mouth.

On examination, her sense of taste seemed to be normal in that she could differentiate upon her stub of a tongue between a faintly acid solution and a sugar solution. Her speech was assessed by a speech therapist as being clearer

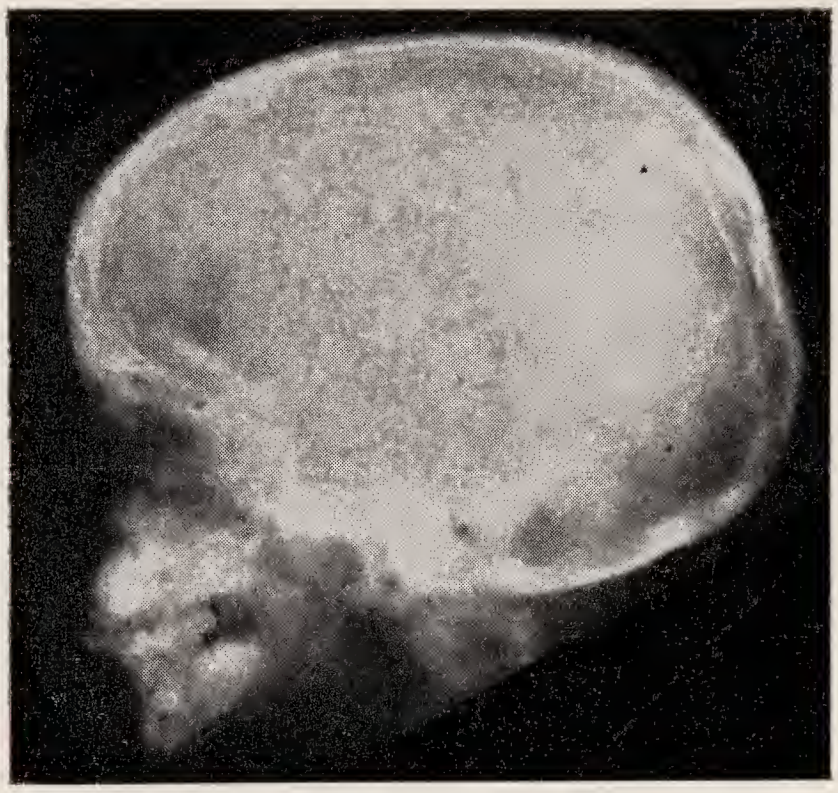


Fig. 1.—Lateral skull radiograph of the patient.

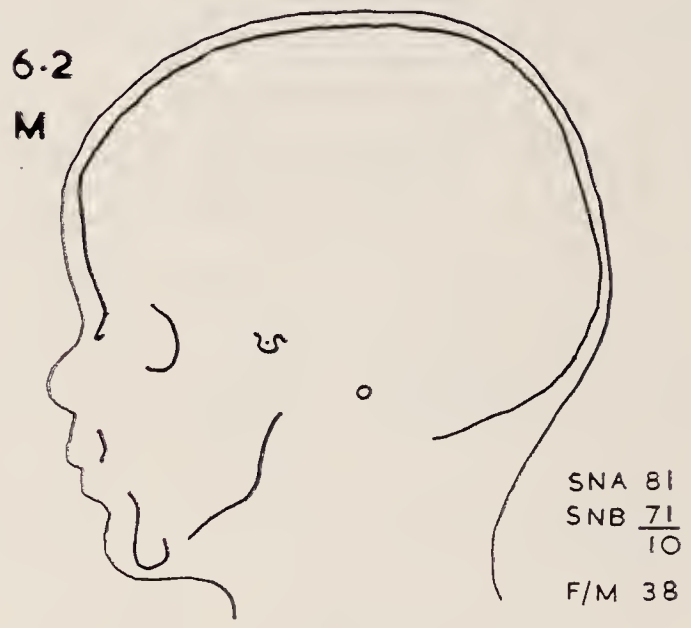


Fig. 2.—Tracing from patient's lateral skull radiograph.

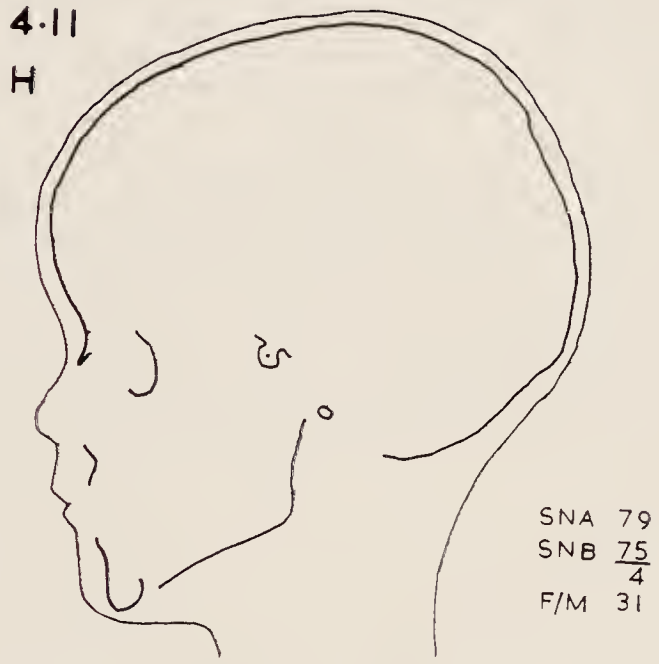


Fig. 3.—Tracing from the patient's younger sister's lateral skull radiograph.

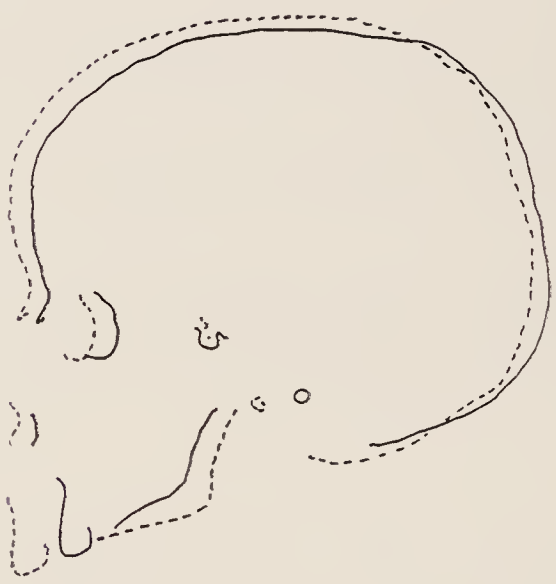


Fig. 4.—Tracings superimposed on the S–N plane, the unbroken line indicating the patient's tracing.

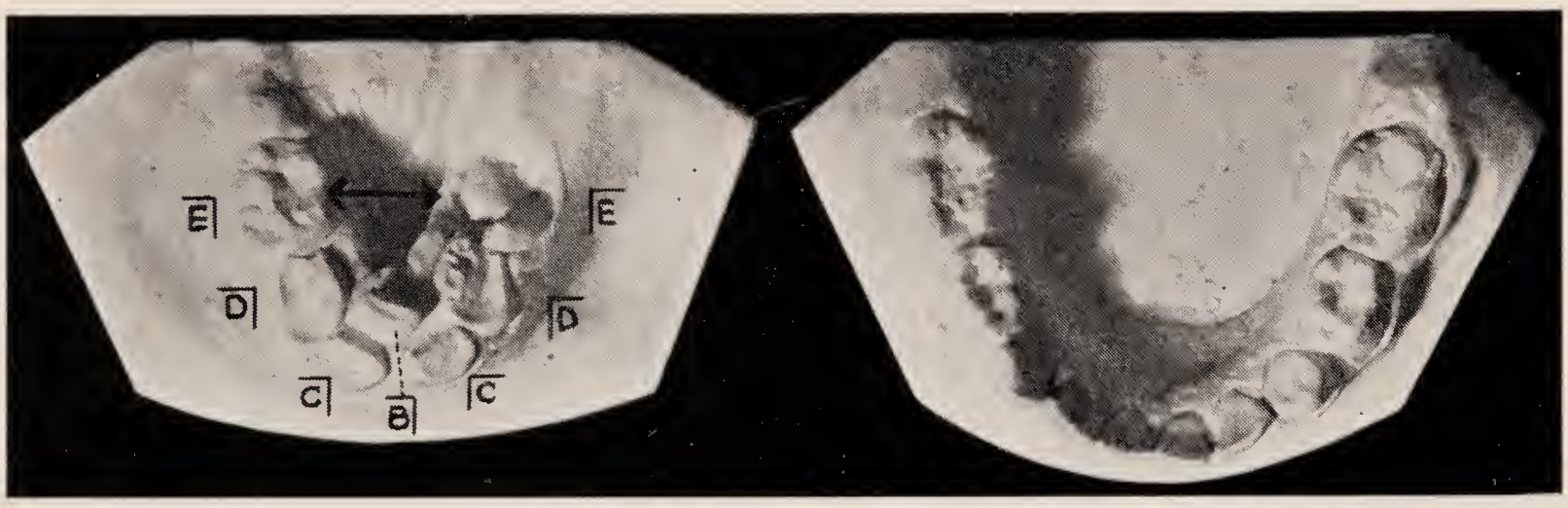
than many children of her age with a normal tongue, and speech therapy was not considered necessary. She had difficulty in pronouncing the labial sounds m, b, and p, and th also presented difficulty [at this point a tape recording of the child's speech was played].

This child's mandible was under-developed (*Fig.* 1), there being a wider angle than usual between the horizontal and ascending rami of the mandible, and the tracings of the patient (*Fig.* 2) confirm that the Frankfort mandibular plane angle is higher than that of her sister (*Fig.* 3). *Fig.* 4 shows them superimposed on the S–N plane.

When compared with the more normal arch of her younger sister (*Fig.* 5), the patient's upper arch is narrow and the lingual cusps of her posterior teeth show marked attrition. Similarly, when the lower models are compared (*Fig.* 6), the patient's arch is so narrow that there is only 9 mm. between the lingual aspect

A B

Fig. 5.—Patient's upper model (A) compared with that of her younger sister (B).



A B

Fig. 6.—Patient's lower model (A) compared with that of her younger sister (B). The distance between the lingual aspect of the patient's $\overline{E|}$ and the very carious $\overline{|E}$ is only 9 mm. Note also the severe attrition on the buccal surface of the patient's posterior teeth. The comparative freedom from attrition of $\overline{B|}$ is probably due to its extreme lingual position. Note absence of $\overline{A|A}$.

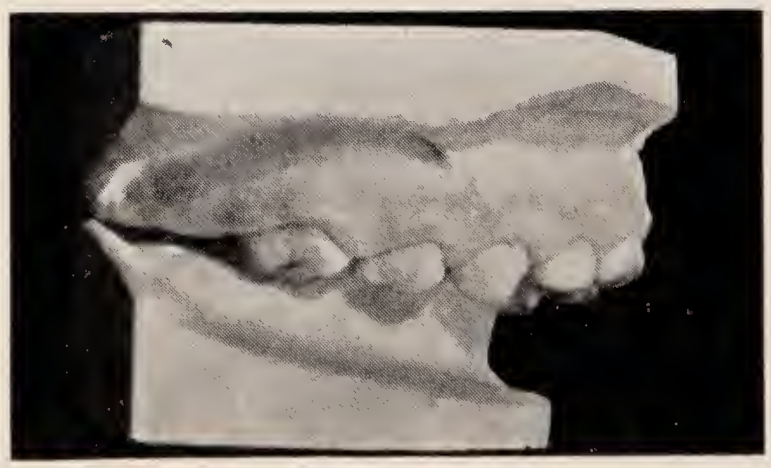


Fig. 7.—Lateral view of the patient's models. The prominence of the upper incisors could have been influenced by her nocturnal thumb-sucking.

of the lower right second deciduous molar and the very carious lower left second deciduous molar. This severe attrition on the buccal

aspect of the patient's lower posterior teeth is the result of the lower arch lying completely inside the upper arch, so that trituration between the molars is more in the nature of an incisal action. The comparative freedom from attrition and the over-eruption of the lower deciduous incisor are, of course, due to its extreme lingual position. The prominence of the patient's upper incisors (*Fig.* 7) may have been influenced by her night-time habit of thumb-sucking.

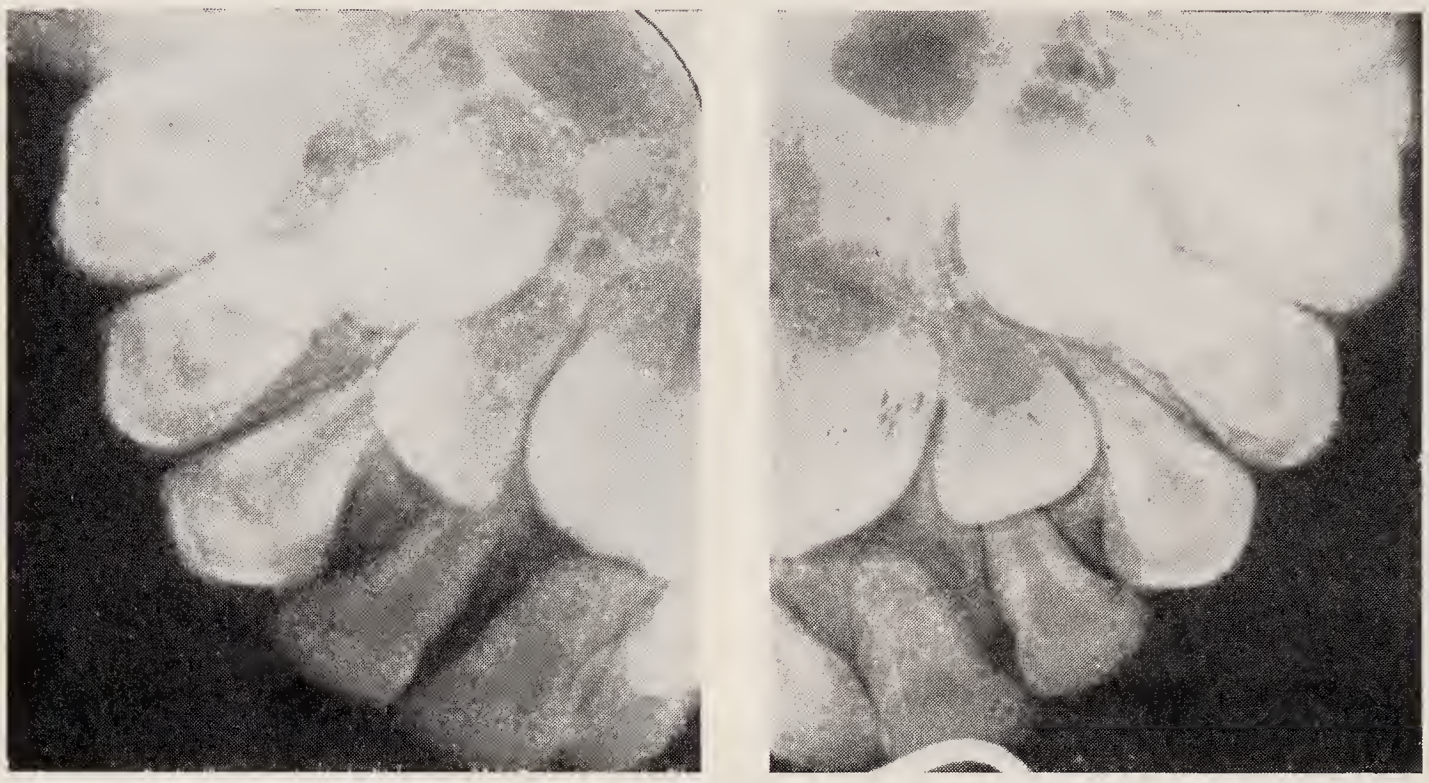


Fig. 8.—Radiographs of the patient's upper teeth.

C B C

Fig. 9.—Radiographs of the patient's lower teeth. Note absence of $\overline{A|A}$.

Radiographs (*Fig.* 8) show all the upper permanent teeth to be present, with the possible exception of the second premolars, and in the lower jaw (*Fig.* 9) the corresponding units would appear to be absent. As far as can be ascertained, all the permanent lower incisors and canines would appear to be present, but their eruption is delayed.

Intra-orally (*Fig.* 10), the over-developed sub-lingual ridges can be seen, together with the tiny stub of a tongue just visible posteriorly.

TREATMENT

Treatment will obviously have to be unorthodox in this case. Apart from conservation of the deciduous teeth, treatment will be deferred as long as possible, preferably until the eruption of the permanent teeth, since any lateral expansion would have to be followed by a fairly permanent retainer in the lower arch.

CONCLUSION

This case shows the tremendous adaptability of the human body and especially the influence

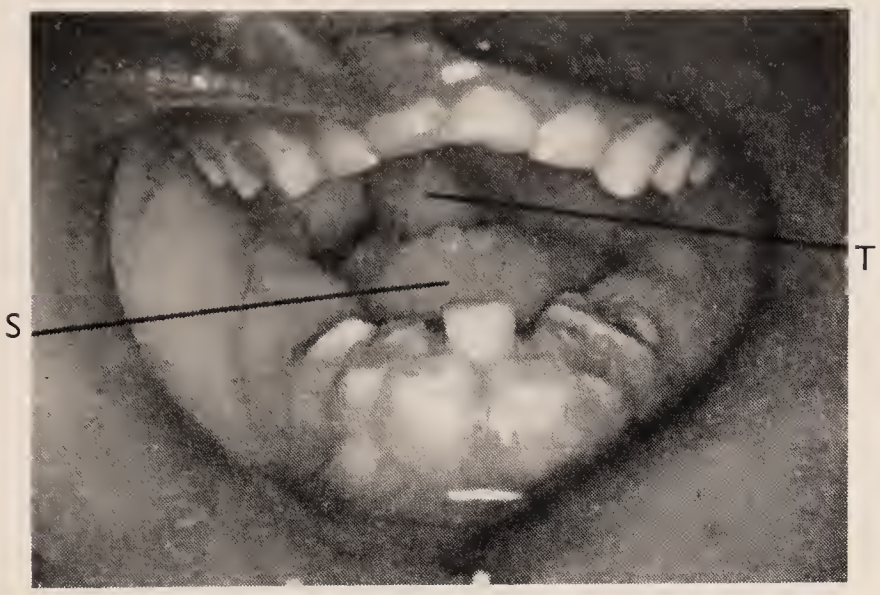


Fig. 10.—Intra-oral view of the floor of the patient's mouth. Note the over-developed sublingual ridges (S) and posteriorly the tiny stub of tongue (T).

of the tongue upon the dental arches. Whether one can go on to suggest that the presence of a tongue is necessary to the development of the non-alveolar portion of the mandible is open to doubt, but it is put forward as a possibility.

Acknowledgements.—I would like to thank Mr. W. Hynes, F.R.C.S., consultant plastic surgeon, for his permission to publish this case and also to Miss J. E. Oliver, of the Speech Therapy Department of the Sheffield Children's Hospital, for drawing this patient to my notice and for help in assessing her speech. My thanks are also due to Mr. J. F. Larway, Chief Photographer of the United Sheffield Hospitals, for the ciné photography [the paper was illustrated by a ciné film], to Mr. R. Cousins of the Dental Hospital for the preparation of the illustrations, and to Mr. P. M. Benzies for help in preparing the tracings.

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DISCUSSION

The President thanked Mr. Gardiner for his most interesting presentation of the case, and said he was to be congratulated on the way he had put it together; it was most instructive.

Mr. H. G. Watkin said that in 1925 he encountered a similar case, a patient aged about eight with about two-thirds of the tongue missing. He was concerned with orthodontics at the Liverpool Dental Hospital at the time, and the patient was taken to him because of her deformity. At first she spoke very badly, but after some twelve months she spoke well, pronouncing "t" and "th" perfectly. She was from a family of seven and was the only one with a deformity. Eventually she obtained a post as a teacher to a family; she spoke so well that she was teaching young children. He could not recall much detail about the case because it was thirty-four years old.

Mr. A. J. Walpole Day thanked Mr. Gardiner and said he felt very guilty himself because some years previously he had seen a similar case but had not reported it. The case was one of a boy of $10\frac{1}{2}$ to 11 years, with fair curly hair and no tongue. An operation was performed and a tongue was made which resembled the top joint of one's middle finger in size and shape. The boy's teeth were rather poor; all the deciduous teeth had gone and the two lower centrals were missing. There was no occlusion. The mandible was small. The child's speech was as good as most children's and better than some.

Dr. R. B. Dockrell said that as reported in the paper he dealt with a similar case with a very small mandible. The child concerned was then about five years of age and the anterior portion of the tongue was missing. Late eruption of the teeth was present, but the speech was good. So far as he knew he did the patient absolutely no good and it was with considerable relief to hear that she later refused to go on wearing an appliance. She had a single lower central incisor lingual to the two canines. No other abnormality could be found at the time, but now she was quite obviously dwarfed.

Mr. Oliver asked whether Mr. Gardiner had gone into the aetiology from the genetic viewpoint?

Mr. Gardiner replied that he had not considered the case beyond the points referred to in the paper. It would bear a considerable amount of research. As far as the mother was concerned there was no other similar case in the family, but it was difficult to get information relating to the father.

The President asked when the condition was first noticed.

Mr. Gardiner said that the deficiency of the tongue was noticed a few hours after birth when the child could not suckle, but the case was brought to his notice a few months previously.

The President said there was presumably no reliable information as to the early state of the arch.

Mr. Gardiner said that was so. His records went back only a few months.

The President said they would be seeing the child concerned the following afternoon. They were all grateful to Mr. Gardiner for presenting the case so fully and so well.

MODIFIED 0·7 mm. LINGUAL ARCH FOR ANTEROPOSTERIOR EXPANSION OF THE MANDIBULAR ARCH

By **D. G. GOULD**, B.D.S., F.D.S., D.Orth. R.C.S.

CASES where there is a slight lack of room for lower premolars can be treated by anteroposterior expansion of the lower arch, provided

Fig. 1.—Molar band with double horizontal tube welded in position.

that the soft-tissue pattern will tolerate some proclination of the lower labial segment. A method of anteroposterior expansion is described which, by adapting the "puller-outer" principle, as described by C. V. Hill (1954), enables one to activate an 0·7-mm. lingual arch wire without removing the appliance from the mouth.

METHOD

Molar bands are made for the lower first permanent molars and a model is made with the bands in position. Double horizontal tubes, made of 5 × 0·15-mm. backed by 3 × 0·1-mm. stainless steel tape, are welded to the lingual surface of the bands so that they are horizontal. (*Fig.* 1.)

A lingual arch of 0·7-mm. stainless steel wire is adapted to the arch with a loop (ABC) in the premolar region. (*Figs.* 1, 2.) A bend is made in the arch at D and the wire beyond D is annealed. The wire is then bent tightly on itself so that it will slip in and out of the double horizontal tubes. The wire is inserted into the tubes and the stop EFG is bent.

The lingual arch with the bands is cemented in the mouth (*Fig.* 3) and is activated to give anteroposterior expansion by gripping the stop EFG with pliers and applying traction so that the loop (ABC) tends to close. Activation is maintained by bending the wire occlusally at E and forming a new stop in the softened wire.

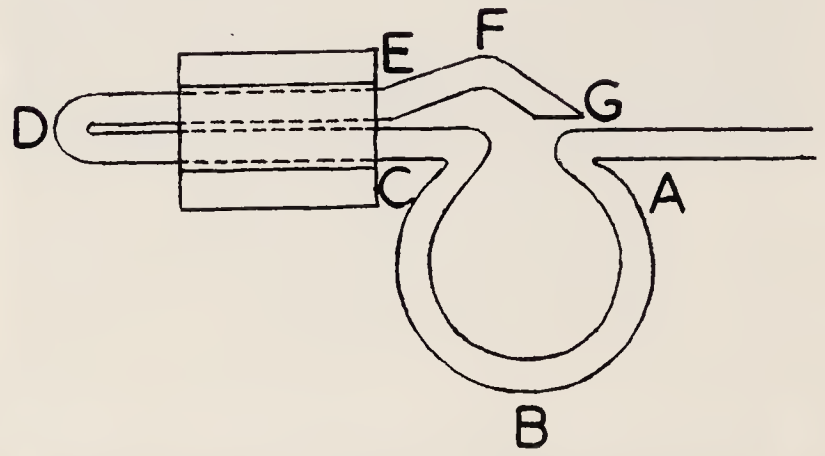

Fig. 2.—Details of "puller-outer" and loop.

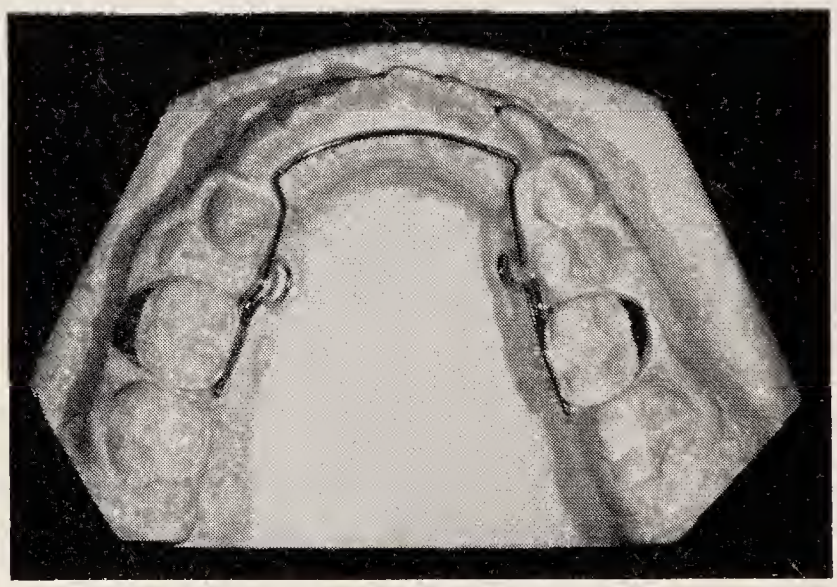

Fig. 3.—Completed lingual arch ready for insertion.

At subsequent visits the activation can be done in a similar way without removing the appliance from the mouth.

Acknowledgements.—I am grateful to Mr. S. G. McCallin, Consultant to the Eastman Dental Hospital, for his help in preparing this article, and to Mr. W. J. Morgan, A.R.P.S., for the photography.

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Demonstration given at the Manchester meeting held on April 18, 1959.

AN INVESTIGATION INTO THE INFLUENCE OF THE SOFT TISSUES ON TOOTH POSITION

By **D. A. DIXON**, F.D.S., D.D.O.
Orthodontic Department, Edinburgh Dental Hospital

THE analysis of the pressures exerted on the teeth by the surrounding tissues is of fundamental importance in many fields of dentistry. The evaluation of an orthodontic, prosthetic, or periodontal problem often depends on concepts held by the clinician on the effect of the surrounding soft tissues on the position of the teeth. This paper will shortly review the present knowledge in this field and will present a new technique for the demonstration of such pressure effects that may influence the tooth position.

Recently, in an orthodontic text-book, Moyers (1958) writes that the teeth are in balance between the lips, cheeks, and the tongue, and when there is a change in the muscular environment the teeth will be moved through the bone until there is again balance. This concept was first put forward in a paper on jaw development by Charles Tomes (1873) in which a case of hypertrophied cheek tissue and resultant arch deformity is described and it is suggested that "the agency of the lips and tongue is that which determines the position of the teeth". This idea has gradually gathered support and is now well established in current teaching.

It is well to consider on what evidence this theory is supported. First, there is a large amount of clinical evidence that when the posture of the lips, cheeks, or tongue is abnormal, the position of the teeth is found to be abnormal also. The influence of the lips on the position of the incisor teeth is well established. With protrusion of the upper incisors there is often a condition described by Sclare (1957) as the "trapped lip". The lower lip is positioned between the lower and upper incisors and is a potent cause of relapse if the orthodontic treatment is not skilfully completed. Nicol (1954) analyses the position of the lip relative to the incisor teeth. He reports that with a deep overbite the upper incisor position is dependent on the relationship of the lower lip to these teeth. Twin studies by Leech (1955) and Townend (1954) give weight to the theory that the position of the upper incisors is controlled by the lower lip. Attention has been focused on abnormal tongue activity in swallowing as a causative agent in malocclusion by the work of Rix (1946). Anterior open bites can be caused by this tongue-thrusting behaviour and may prove very resistant to correction.

More extreme examples of the interconnexion of these factors are occasionally seen. With macroglossia the teeth are usually spaced, and with aglossia the arches may be contracted. In cases of cleft lip and palate the operation on the lip can produce an abnormally tight upper lip due to the formation on scar tissue. The effect of this is often to deflect the erupting upper incisors palatally and collapse the arch segments. Deformities of the dental arch associated with various forms of muscular paralysis have been recorded by a number of observers. The literature on this aspect is thoroughly covered by Brash, McKeag, and Scott (1956). The tendency to relate these findings in severe abnormalities to the environment of the normal mouth must be resisted. However, the preceding evidence, if seen in isolation, appears convincing, and the conclusion that the teeth are balanced between opposing muscular forces is utilized in both prosthetic and orthodontic treatment procedures. It is, therefore, all the more necessary that the subject be closely examined, and evidence both for and against presented before final evaluation.

A clinical feature that is not often described is that of indentation of the soft tissues by

A demonstration given at the Manchester meeting held on April 18, 1959.

the teeth. This is sometimes observed on the lower lip when this is positioned between the upper and lower incisors (*Fig.* 1). The tongue itself is not frequently seen to be indented by the premolars and molars, and examples are occasionally seen in other parts of the mouth.

Fig. 1.—Indentation of the lower lip by the upper incisors.

This may indicate that although the soft tissues are applying pressure to the teeth, these do not always move into a completely neutral position with their environment.

The maximum pressures exerted by the lips and tongue on dynamometers were measured by Friel (1926). The tongue pressures recorded consistently exceeded the lip pressures in this fine study. A further number of investigations on oral pressures have been reported in recent years using manometric techniques. Stevens (1956), Hopkin and McEwan (1957), Kydd (1957), and Sims (1958) report that the pressures exerted by the tongue exceed lip pressures, and no correlation between incisor position and such pressures has been found. Simultaneously with these investigations Winders (1956, 1958) has utilized a strain gauge technique to study the pressures exerted by soft tissues on the teeth when swallowing and at rest. He states that during function there is an imbalance of myometric forces acting on the dentition—the tongue exerting a much greater force than the peri-oral musculature.

Criticism of the general validity of these experimental findings has been put forward by Graber (1958), who considers that the active functional pressures may be of less importance than the more constant postural effects and that the pressures of the tissue masses may be the main factor in determining tooth position. Therefore, there appeared a need for a technique to show the total effect of the forces, both functional and postural, exerted on the tooth during a period of time and capable of revealing the position of balance that would be taken up by a tooth exposed to these forces. Viscosity techniques are a promising line of attack, and it is a simple method which has been developed from this line of thought that is demonstrated. This gives a visual record of the position of balance of the teeth in their soft tissues environment.

The method adopted was to attach an artificial tooth to a small partial denture in such a way that it was freely movable buccolingually (*Fig.* 2). On this denture a crosspiece of edgewise arch wire is fixed and the tooth is attached to this through the agency of a precision-fitted piece of rectangular tubing.

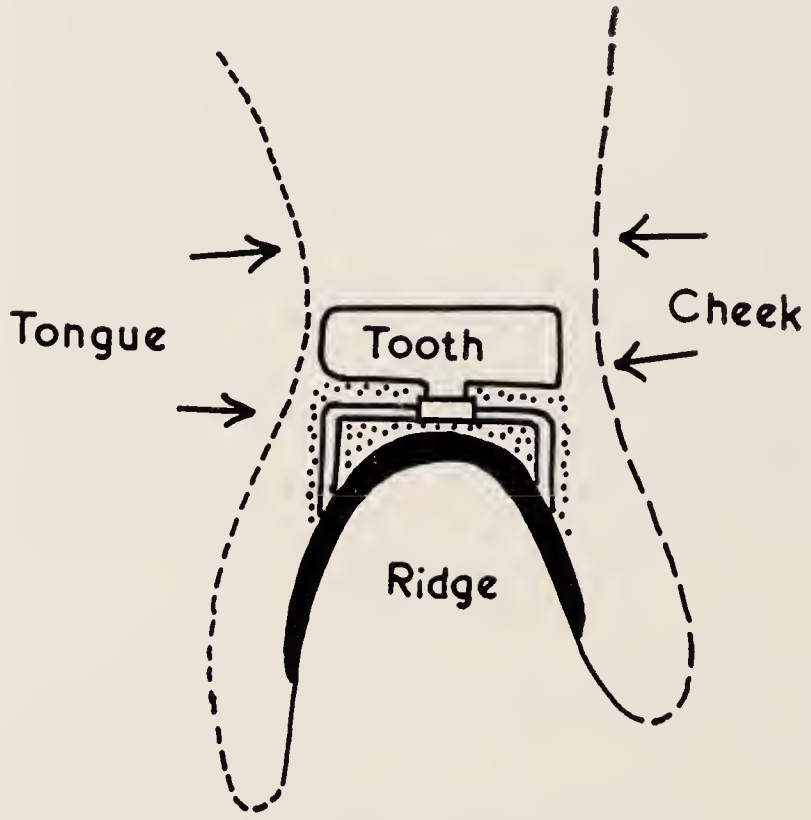

Fig. 2.—Diagram of the apparatus.

This allows movement freely across the ridge but imparts stability in other directions. By filling the intervening space between the tooth and the plate with chewing-gum, it was found that the tooth would move to light forces in the region of 5 g., but would remain stable in position when the force was removed.

Dental students who had dentitions with normal relationship between the arches but missing teeth in the buccal segments volunteered to wear these appliances. The tooth was made so as to imitate the form and position of the missing tooth as far as possible and was cleared from the occlusion. The denture support was as small as possible and the appliance worn for a period to accustom the wearer to it and to eliminate any reflex movements caused by the pressure of an unaccustomed object in the mouth.

These appliances have been used in a number of instances in the molar and premolar regions. The method adopted has been to move the tooth to an extreme buccal position and the plate is worn for a night and the position recorded. The same procedure is carried out with the tooth in an extreme lingual position and the mean of three recordings, if reasonably coincident, is taken (*Fig.* 3). This drawing shows the results of the investigation so far. It can be seen that the effect of the tongue in replacing the tooth to a position in the line of the arch is generally more vigorous than the effects of the cheeks (Nos. 3, 4, 5, 7). There is considerable variation in each subject, and in one case (No. 1) the tooth was stable for a considerable distance either buccal or lingual to the line of the arch. The tendency of the tooth to move to a buccal position is well shown in *Fig.* 4. In this subject the artificial teeth were placed in the line of the arch before the appliances were inserted in the mouth. The upper tooth moved to the buccal slightly, while the lower tooth is a considerable distance buccal to its original position. Although this simple method does not lend itself to a detailed analysis, it may be said that the teeth in the buccal segments in the young adult are not balanced in position by the checks and tongue. In this small series the state of imbalance is more marked in the lower arch.

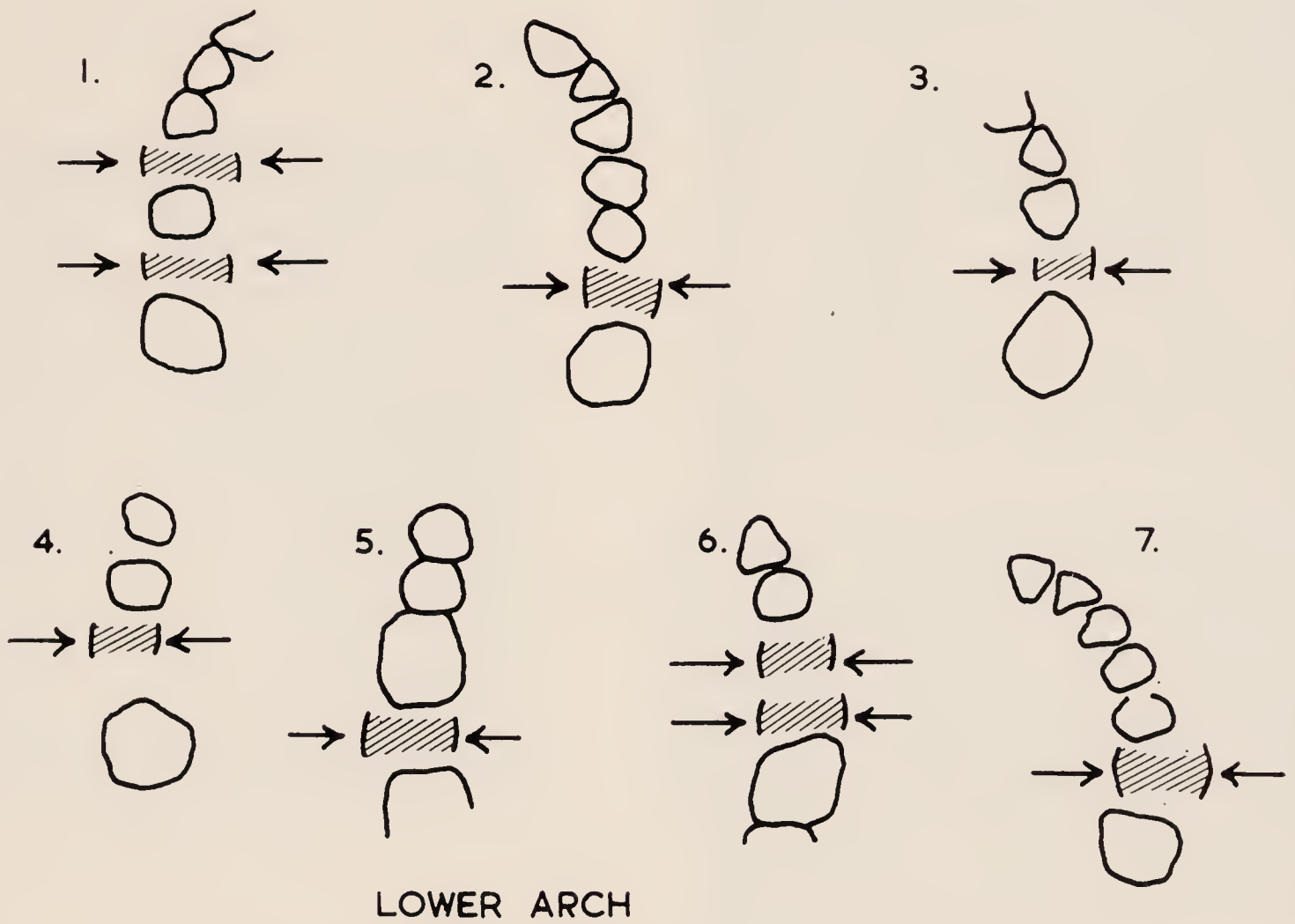

Fig. 3.—Tracings of experimental results in individual subjects.

A number of other factors which affect the arch shape are known. The effect of the inherited morphology or the occlusion have not been discussed. However, it is worth while to

analyse the evidence on the effect of the soft tissues as far as this extends at present. First, a considerable amount of clinical evidence suggests that when there is an arch malrelationship, or some abnormality of posture or activity of the soft tissues exists, the

Fig. 4.—Experimental appliances replaced on models.

position of the teeth can be influenced by the pressures exerted by the soft tissues. Secondly, a number of investigations using different experimental techniques have collectively shown that this concept cannot be extended to state that the teeth are balanced between soft-tissue pressures in the normal occlusion of the adult. Finally, the incomplete state of knowledge at present, and the individual variation which is apparent, indicate that dogmatic statements should be avoided.

SUMMARY

The concept that the dentition is in a state of balance in the soft tissues is examined. The clinical and experimental evidence on this subject is reviewed, and it is concluded that this concept cannot be supported in the light of present knowledge. A new method of investigation of oral pressure effects is described.

Acknowledgements.—I should like to thank Mr. Hopkin and Dr. Logan, Consultants in Orthodontics, Edinburgh Dental Hospital, for their interest and help. The photographs are the expert work of Miss Bensted, Mr. Hunter, and Mr. Standin, and finally the interest and co-operation of those who wore the appliances should be recorded.

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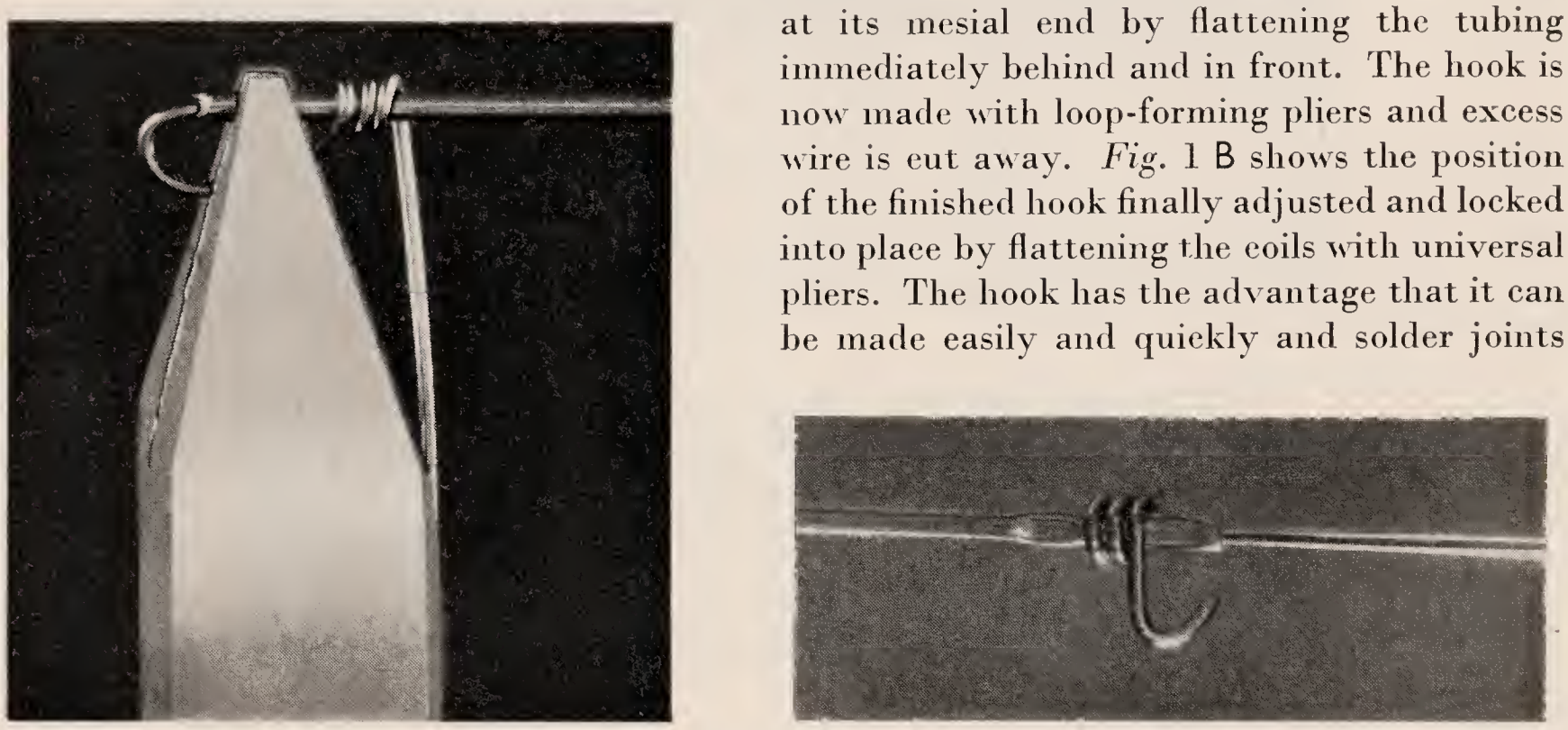
AIDS TO APPLIANCE TECHNIQUE

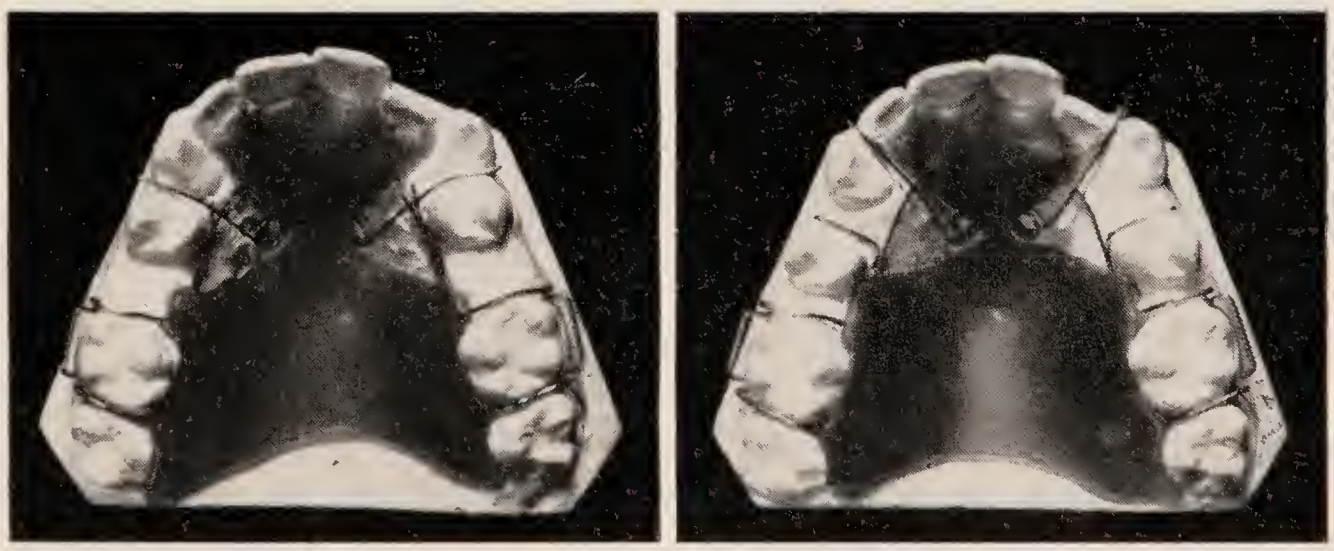
By **MRS. S. J. JACKSON**, F.D.S., D.Orth. R.C.S.
Lecturer, Manchester Dental Hospital

1. The Construction of a Twin Wire Arch Intermaxillary Hook.—The hook is made from 0·5-mm. hard stainless steel wire and is constructed in the following way: three coils are made by winding the wire round a spare piece of twin arch end tubing to give a slide fit on the tube. To prevent the tube and wire slipping in the plier beaks as the coils are wound the wire is pushed down the end tube, and doubled back, and as the two are held parallel together with universal pliers, an excellent purchase is obtained (*Fig.* 1 A). The wire is cut off about an inch from the coils, but the hook is not made. The attachment can be prefabricated up to this stage. It is slid easily onto the end tubing of the twin arch and held at its mesial end by flattening the tubing immediately behind and in front. The hook is now made with loop-forming pliers and excess wire is cut away. *Fig.* 1 B shows the position of the finished hook finally adjusted and locked into place by flattening the coils with universal pliers. The hook has the advantage that it can be made easily and quickly and solder joints are avoided. It can be accurately positioned and added to an arch wire, and the rigid hold gained from the flattened coils and end tubing prevents the hook swinging out under the influence of intermaxillary elastics.



A B

Fig. 1.—A, Making the coils; B, The finished hook locked in position.



A B

Fig. 2.—A, Position of retaining wire during retraction of $\underline{4|4}$; B, Wire bent at right angles to retain $\underline{4|4}$ during retraction of $\underline{3|3}$.

Demonstration given at the Manchester meeting held on April 18, 1959.

2. A Retaining Wire used when Retracting Two Teeth with a Single Finger Spring.—If an additional wire is incorporated into finger spring construction running parallel with the guide wire it can be used to retain one tooth after it has been retracted, allowing the spring to be used to move a second tooth into the space (*Figs.* 2 A, B). Its most useful application is in the retraction of $\frac{43|34}{}$.

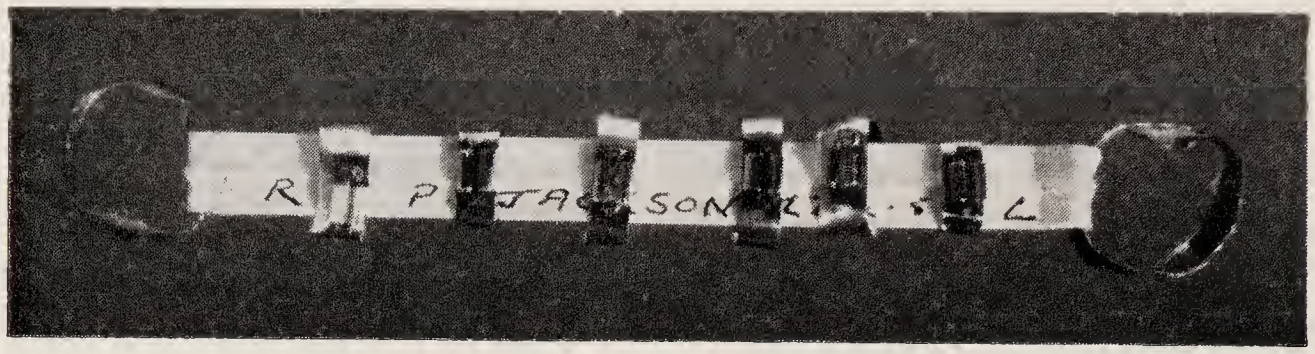


Fig. 3.—Bands kept in order on card strip.

3. A Simple Method of Storing Bands.—Orthodontic bands are often constructed at one visit and inserted at another. A simple method of keeping these bands in order is to thread them on to a strip of card with a wire strengthener. The patient's name, date of next appointment, and "Right" and "Left" can be marked on the card (*Fig.* 3). These strips are widely used by laundries and gardeners. Storing bands on strips of wax may be the subsequent cause of a poor cement bond between tooth and band.

I wish to express my thanks to the Department of Medical Illustration, United Manchester Hospitals, for the photographs.

THE LATERAL ARM IN REMOVABLE APPLIANCE THERAPY

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Orthodontic Service, Lancashire County Council

The lateral arm is a 0·9-mm. wire extension from the distal aspect of the appliance passing forward across the buccal segment towards the midline, its length depending upon the tooth or teeth to be moved. Its distal end has a U loop for adjustments, and its mesial end is flattened and modified according to the type of movement to be employed, as described below. Its use can be extended to:—

1. Rotation of anterior teeth.
2. Palatal or lingual movement of incisors, canines, and premolars.
3. Framework for springs for individual tooth movement.
4. Framework for single or multiple apron springs.
5. Retention appliances.

ROTATION OF TEETH

The lateral arm extends from the molar area to the tooth to be rotated, the anterior end being curved to engage the everted edge of the rotated incisor. Palatally a boxed, coiled U spring of 0·5-mm. wire engages the opposite end of the tooth. The main pressure is exerted by the palatal spring, the lateral arm being almost passive, but activated sufficiently so that the tooth rotates between two diagonally opposed pressures (*Figs.* 1, 2).

Fig. 1.

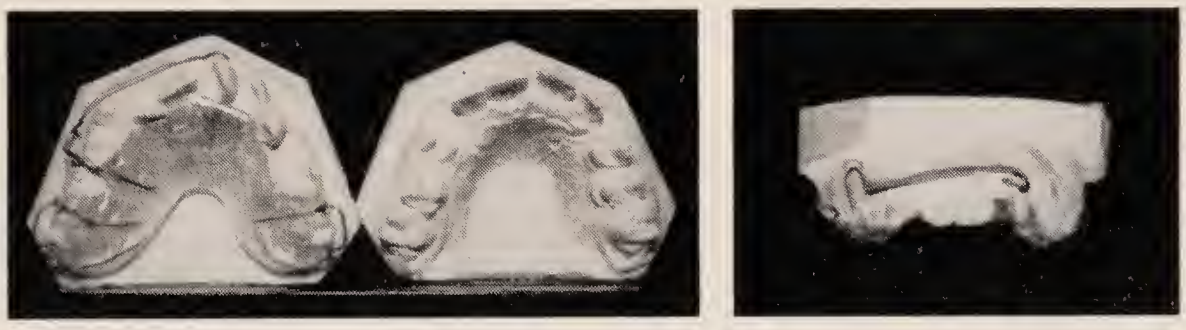

Fig. 2.

Fig. 3.

Fig. 1 illustrates a case in which $\underline{|1}$ is rotated through an angle of 85° with an auxiliary spring on $\underline{1|}$ moving it distally to provide sufficient room for $\underline{|1}$ in the arch.

Demonstration given at the Manchester meeting held on April 18, 1959.

Fig. 2 demonstrates the rotation of |1 which was originally in linguoversion together with 21|, the labial movement being effected by opening the bite and operating the coiled palatal springs only. When the teeth had been moved labially |1 was rotated by activating the lateral arm.

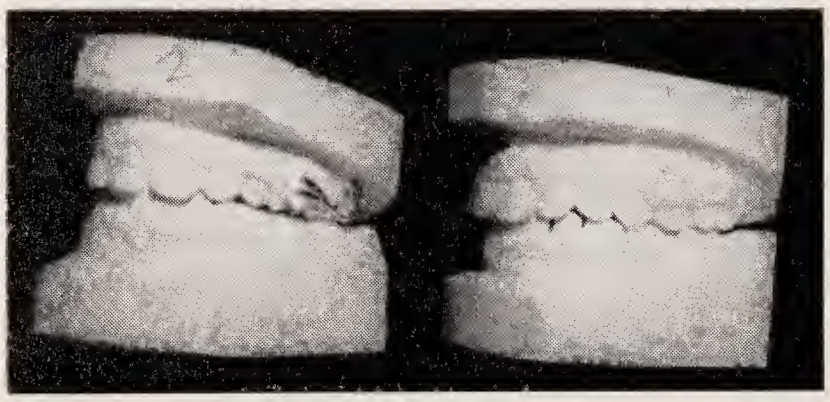

Fig. 4.

PALATAL AND LINGUAL MOVEMENT OF TEETH

Fig. 3 shows the lateral arm modified to correct overcrowding in the labial and buccal segments. Following the removal of 4| the lateral arm has a T-shape dapron spring wound on it to move 3| distopalatally, and its curved anterior end is activated to retract 1|. A coiled palatal spring moves 2| labially. This appliance also demonstrates the use of the lateral arm as a framework for springs for individual tooth movement. *Figs.* 10, 11 show the appliance in use bilaterally in the correction of 2|3. *Fig.* 4 shows the simple palatal movement of |4 into normal occlusion in the arch.

Fig. 5.

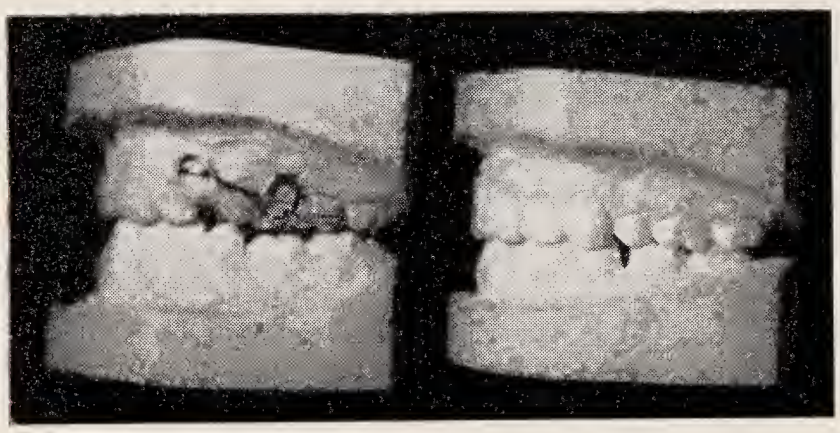

Fig. 6.

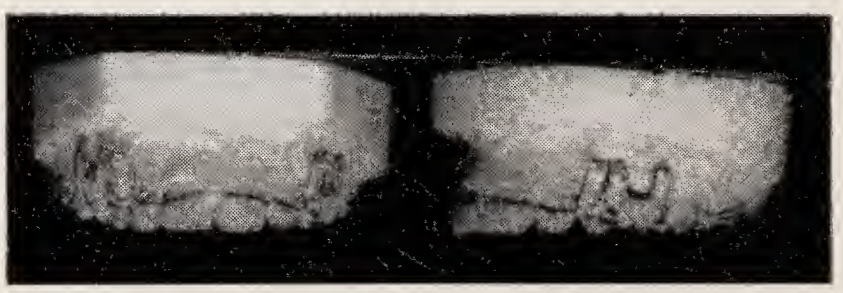

Fig. 7.

Fig. 8.

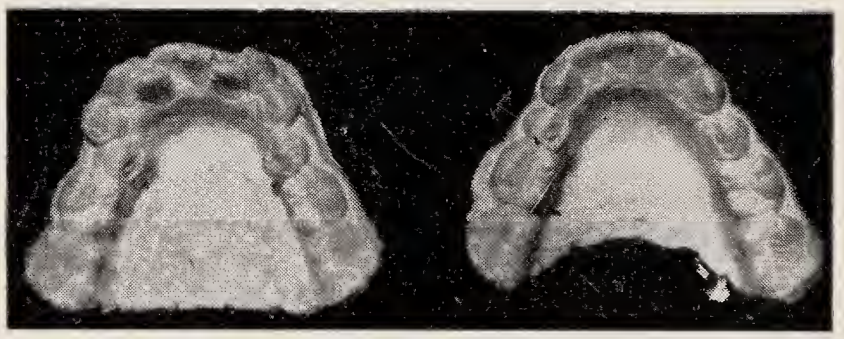

Fig. 9.

Fig. 10.

Fig. 11.

RETRACTION OF CANINE AND PREMOLAR TEETH

The flattened end of the arm is curved to embrace the mesial aspect of the tooth to be moved, and the distal loop activated to exert pressure on this surface. Due to the stability of the lateral arm, and the area of the crown surface engaged, bodily movement of teeth is achieved. *Figs.* 5, 6, 8, 9 illustrate the construction and action of these appliances.

FRAMEWORK FOR SINGLE OR MULTIPLE APRON SPRINGS

The use of an appliance with a high labial bow for the retraction of the labial segment sometimes produces traumatic pressure against soft tissues of the lip at the mucobuccal fold. As the teeth are retracted, there is a varying degree of upward riding of the bow which may encroach on the soft tissues, more especially where the depth of the alveolar area is small and the frenal tissues thickened and curved downwards close to the alveolar margin.

The more pronounced the inclination of the long axis of the teeth in the labial segment, the more likely the upward movement will occur as retraction proceeds, and the pressure may involve any area in the mucobuccal fold between the limits of the high labial bow.

Various appliances have been designed to obviate the use of the high labial bow when employing apron springs, the disadvantage being the difficulty of repair if fracture should occur, which usually involves a major workroom procedure or a new appliance. These difficulties may be overcome by the use of bilateral arms extending as far as the canines on either side to form a framework for the fixation of one or more apron springs. This framework is sufficiently rigid, and in the event of apron spring fracture, a new one can be rewound at the chairside. The minimum amount of framework lies between the alveolar and lip tissues, and continued comfort during use is ensured. An added feature is that the curved anterior ends of the arms can overlie the vertical sides of the apron springs, thus preventing labial distortion during use. *Fig.* 7 illustrates this type of appliance with a triple apron spring for the retraction of the labial segment.

Pressure exerted by the lateral arms in tooth movement is regulated by means of a Richmond pressure gauge, and varied between 15 grammes in the rotation of anterior teeth to 60 grammes in the retraction of canines as initial pressures. Periodic radiographic examinations were made during and following treatment, and in no case has any pathological change been observed. Comparative studies with fixed appliances using more continuous forces showed the latter to produce evidence of bone and root changes.

Acknowledgements.—Appreciation is expressed to Dr. S. C. Gawne, County Medical Officer of Health, Lancashire County Council, and Mr. L. B. Corner, Principal School Dental Officer, for permission to use cases treated in the Orthodontic Clinic.

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A MODIFIED ELECTROLYTE FOR POLISHING STAINLESS STEEL

By **J. H. MARTIN**, L.D.S., D.Orth. R.C.S.
The Charles Clifford Dental Hospital, Sheffield

In 1948 Professor Hallet published the formula for an electrolyte suitable for polishing stainless steel, and in 1955 Duffield gave an account of two solutions which he used to clean chrome cobalt castings. The method of thinning a spring has necessitated the development of a solution whose action takes as little of the technician's time as possible.

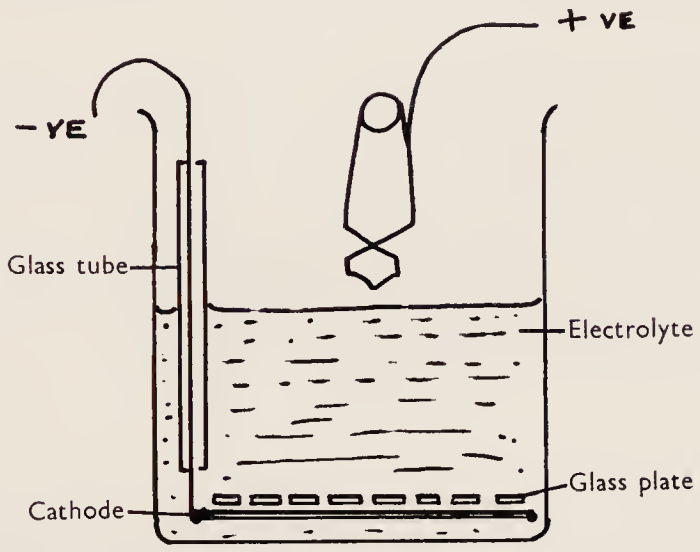

Fig. 1.—To show arrangement of cathode and anode in the electrolyte.

In conjunction with the Metallurgy department of the University of Sheffield the following solution has been tried and found to have a useful action:—

Sulphuric acid	41	per	cent	by	volume
Phosphoric acid	45	,,	,,	,,	,,
Ferrous sulphate	5	,,	,,	,,	,,
Water	9	,,	,,	,,	,,

It is based on a common industrial electrolyte with the addition of the ferrous sulphate to act as a buffer.

The demonstration showed an arrangement of apparatus suitable for the general practitioner, viz.: a 4 amp. battery charger connected to a circular stainless steel cathode which was placed in a 500 ml. beaker. A 1·0-mm. wire to produce a self-supporting perforated glass plate was placed over the cathode to prevent the appliance touching the cathode and causing an accidental short circuit. A home-made spring clip to hold the article was connected to the positive lead (*Fig.* 1). A high polish was shown to be produced on a previously charred wire within about 10 seconds. The glass safety plate acts as a barrier to the liberation of gas bubbles from the cathode and thereby slows the action of the electrolyte; if it is removed a 1·0-mm. wire can be reduced to a diameter of 0·7 mm. in 12 minutes (*Fig.* 2).

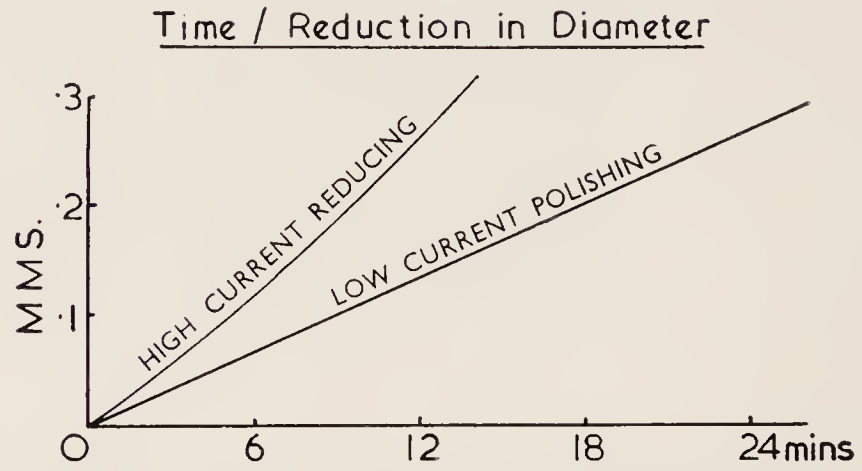

Fig. 2.—Graph indicating rate of dissolution of stainless steel wire.

A MODIFIED JACKSON SPRING

By **J. H. MARTIN**, L.D.S., D.Orth. R.C.S.
The Charles Clifford Dental Hospital, Sheffield

In 1904 V. H. Jackson published a diagram of a labial spring to retrocline upper incisors. It consisted primarily of a self-straightening wire. Both ends were free and the appliance tended to be unwieldy and difficult to adjust adequately. The first modification was produced by

Demonstrations given at the Manchester meeting held on April 18, 1959.

fixing one end of the spring to a stiff labial bow. This caused a varying pressure along the

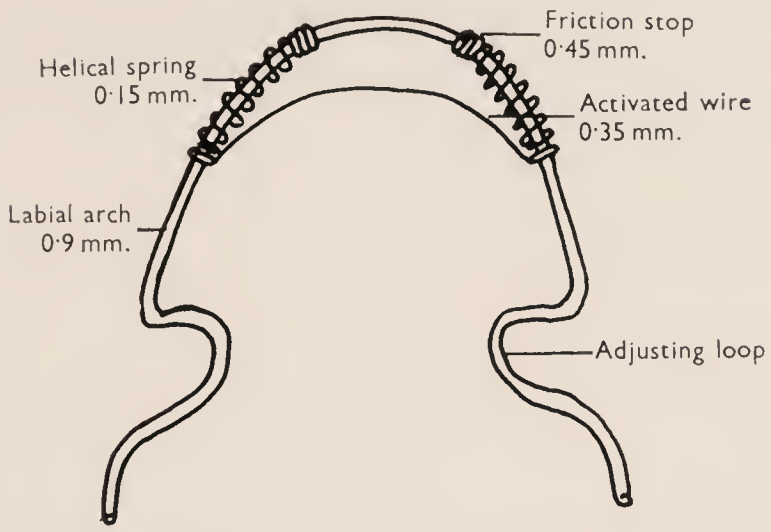

Fig. 1.—To show arrangement of helical spring on labial arch.

length of the wire and was partially overcome by fixing a similar wire to the opposite side of the labial bow. Because of this, adjustment was limited.

By using helical springs on a facial arch these difficulties have been overcome. The demonstration showed cases in which the modified Jackson spring had been used and details of the construction of the spring are shown in *Fig.* 1. The completed spring arch may be attached to buccal tubes on molar bands or soldered to the cribs of a removable plate. The advantages claimed are:—

1. Compactness and ease of adjustment.
2. Usefulness in cases of marginal gingivitis where a conventional apron spring is contra-indicated.
3. Ease of dealing with asymmetrical conditions by moving the friction stops and the activated wire round the arch.

EARLY DEVELOPMENT OF THE DECIDUOUS DENTITION

(OROFACIAL MUSCULAR DEVELOPMENT)

By **B. C. LEIGHTON**, L.D.S. R.C.S., H.D.D. R.F.P.S.
King's College Hospital Dental School

It is nearly fifty years since Northcroft (1910), in the course of his Presidential Address to the British Society for the Study of Orthodontics, expressed amazement at the enormous number of abnormalities that are foreshadowed in the deciduous dentition before the age of 5 years. Reference to other literature of the early twentieth century suggests that it was widely believed that malocclusions of the deciduous dentition rarely occurred, a view shared even by Edward Angle (1907). In 1912 E. A. Bogue wrote: "We have been assured that the temporary teeth are always or usually regular, but I shall show that from the age of 3 to 6 years the temporary teeth are frequently irregular in position, and that they fairly indicate the irregularities which are impending among the permanent teeth."

The same belief was later expressed by J. H. Badcock (1931) when addressing the Second International Orthodontic Congress. He said: "Irregularities of the second set of teeth are foreshadowed in the first, and even at birth future malrelation of the jaws may often be detected."

Although the published works of Ainsworth, Chapman, Hellman, Northcroft, Pitts, Wilson Charles, and others have shown conclusively that malocclusion does occur in the deciduous dentition, there has been a remarkable paucity of evidence to support Bogue's assertion that the deciduous does foreshadow the permanent dentition. In fact so little seemed to be known about dental development during the early years of life that it was decided that much might be gained from a longitudinal survey starting from birth. By this means it may be possible to observe the environment into which the deciduous teeth erupt, and then to follow subsequent changes, both of environment and of morphology. A survey was, therefore, started in 1952 in the Maternity Department of King's College Hospital. About 550 babies were examined with the intention of following them up; however, there was considerable wastage for a variety of reasons, and there are now only about 200 of the original cases still attending. The children were examined at birth, at six months, and then at yearly intervals. Records were kept of birth conditions, and at each visit impressions were taken and notes made of sucking habits, lip posture, swallowing behaviour, and weight and height. From the age of $3\frac{1}{2}$ lateral X-rays were taken of the majority of children. It is not possible to cover all the information gained from this survey in one paper, which is limited, therefore, to that part of the survey dealing with orofacial muscular behaviour. Although this subject is at present rather nebulous, and, by its nature, does not lend itself to mathematical analysis, it has gained so much prominence during the last two years that some attempt should be made, in spite of the difficulties, to subject it to analysis.

Since 1946, when R. E. Rix drew attention to differences of swallowing behaviour in older children, and suggested that some of these may be associated with malocclusion, there has been speculation on the origin of those behaviour patterns in which swallowing takes place with the teeth apart.

Nord (1959) was convinced that the behaviour of the tongue and lower lip during deglutition is determined by the incisor relationship, a large overjet encouraging tongue to lip contact at the moment of swallowing. He also denied any hereditary factor in determining behaviour on the ground that

Given at the meeting held on October 12, 1959.

exercises can be used to alter oromuscular bchaviour.

Popovie-Ejdus (1959), after examining 271 children between 2 and 13 years of age, concluded that abnormal swallowing represents a delay in the functional adaptation of the musculature. He based his opinion on the difference of incidence of the infantile type of swallowing that he found between 2 years (49 per cent) and 12 years (23 per cent).

In 1952 Gwynne-Evans, after describing the intermediate position of orofacial muscles between visceral and somatic types of behaviour, concluded that swallowing with the teeth apart was often a manifestation of the predominance of a visceral type of behaviour. In 1955 he stated that "it is quite likely that individual characteristics of the atypical swallowing behaviour are inherited".

Ballard (1952) was not at all convinced that the abnormal swallow could be said to be a continuation of the infantile swallow. He had thought originally that many of these abnormal swallows resulted from an abnormality of the skeletal pattern in early childhood, and that behaviour patterns of the lips and tongue during swallowing became abnormal in their attempt to adjust themselves to this abnormality. He had found, however, that many abnormal swallowing actions were based on an entirely normal skeletal pattern, and many were present in early childhood when every other factor appeared to be normal. He had examined a large number of children between the ages of 2 and 5 years: the abnormal swallow was present in a considerable percentage of them (although most of the children with an abnormal swallow had a normal skeletal pattern), and its manifestation in the deciduous dentition was a slight degree of increased overjet and reduced overbite in the incisor region. He still felt that an explanation of the abnormal swallow was that it was inherited. It should be mentioned, however, that Ballard offered no evidence at the time to support his researches on very young children. In 1955 Ballard still asserted that "it would appear, then, that patterns of motor activity develop endogenously and that what we have thought to be learning is, in fact, the result of the processes of maturation of the central nervous system".

It would appear, therefore, that the variations of swallowing behaviour seen in older children might arise in a number of possible ways:—

1. They may arise because the morphological environment renders normal swallowing difficult or even impossible.
2. They may be either a failure or delay in maturation of the infant suckling behaviour.
3. They may be the result of an inherent endogenous pattern of behaviour, operating independently of skeletal morphology.

In order to elucidate this problem further, a logical step would be the examination of a series of children periodically from birth, recording details of both morphology and behaviour. By this means it may be possible to learn whether subsequent atypical swallowing behaviour is associated with a particular arch relationship at birth, at what age behaviour becomes differentiated into types, and whether there are any signs that behaviour matures.

It had originally been intended to rely on clinical examination to record details of swallowing behaviour. This was found, however, to be unsatisfactory, especially if subsequent comparison were to be made. There was also the disadvantage that when the assessment was made other details of morphology would be known; this may permit an unconscious tendency to fit the behaviour to the morphology. It seemed desirable, therefore, to make some permanent record of the swallowing behaviour of these children. For accomplishing this there are a number of possibilities:—

1. Ciné photography.
2. Ciné X-ray photography using an image intensifier.
3. Electromyography.
4. Pressure gauges distributed at strategic points in the mouth.

The last two methods are only of value when some knowledge has already been obtained about the type of behaviour being examined. Furthermore, they would tax the

patience of the keenest investigator on such young children. The use of ciné film seemed to offer the most practical method of recording in spite of the disadvantage that only movements of the lips would be shown. The possibility of using 8-mm. ciné film was suggested by Mr. K. P. Liddelow, who had been experimenting with it as a medium for teaching. This would be not only a permanent record suitable for comparison with subsequent film, but could be played repeatedly for closer analysis independently of other clinical findings. Its comparative cheapness and simplicity make it possible to film the children from the age of 18 months. In order to overcome the disadvantage that only movements of the lips are recorded, attempts were made to part the lips during swallowing to show activity within the mouth. This, however, was found to upset behaviour sufficiently to render such observations useless. It seemed, therefore, that if the typical behaviour of the tongue and mandible are to be observed, the examination should be carried out without interfering with the movement.

Ciné X-ray film has the advantage of offering information about tongue behaviour, as well as movements of the mandible. This film can only be prepared, however, by using an image intensifier. At present the use of this machine is limited by the amount of radiation considered safe for the patient, that is, about 10 sec. filming for a 3-year-old. Being both large and expensive it is difficult to gain access to this equipment. Owing to the generosity of Dr. I. MacLaren, the Director of the X-ray Department of St. Thomas's Hospital, permission was obtained to take 12 cases to St. Thomas's Hospital for this examination. The number was limited for geographical and economic reasons.

Table I.—Mean Dimensions of Overbite at Birth of Infants grouped according to the Position of the Tongue at Rest
(There is a significant difference at the 5 per cent level.)

	No. of Cases	*Mean mm.*	*S.E.*
Tongue between gum pads	261	+0·32	±0·103
Tongue confined to lingual vestibule	85	+1·44	±0·171

To film only the idle swallow would have involved more patience than either the operator or the child possessed, as it takes place so infrequently at this age, and they cannot be induced to swallow to order. In order to induce swallowing a stimulant was found to be necessary; for this purpose chocolate seemed the most universally acceptable.

As access to the infants was not offered when suckling, it was not possible to make consistent observations of the suckling behaviour of all subjects. It was found, however, that the infants would quite readily suck at a finger placed in the mouth. In about 15 per cent of cases the tongue failed to be protruded between the lower gum pad and the finger. This was later confirmed on a few cases when a bottle and teat were substituted. Similarly, about 23 per cent of cases were found not to protrude the tongue between the gum pads at rest. It was found necessary to make this particular observation on the infant while still asleep in the cot. Even then, only one opportunity was offered, since the immediate reaction to touch on the lips is protrusion of the tongue. Both of these conditions showed statistically significant association with an increased anterior overbite of the gum pads at birth (*Tables I* and *II*). Although it is impossible to say whether the tongue position is determined by the amount of overbite or vice versa, it is, perhaps, suggestive that the distribution of cases was much more unequal where the overbite was least. Apart from this there appeared to be no obvious variation in the suckling behaviour of infants at birth.

Table II.—Mean Dimensions of Overbite at Birth of Infants grouped according to the Position of the Tongue

	No. of Cases	*Mean mm.*	*S.E.*
Tongue penetrating between gum pads	141	+0·07	±0·143
Tongue confined to lingual vestibule	37	+1·04	±0·264

Whereas, at birth, it had been quite easy to approximate the gum pads, by the age of 6–8 months, when the deciduous incisors are about to erupt, considerable resistance was offered to this manœuvre. Although this would

appear to be protective, it was not associated necessarily with any previous painful experience, because it occurred in cases where there was an anterior space between the gum pads and the incisors had not erupted. In spite of this reluctance to bring the gum pads into contact, there was no hesitation in biting hard on a finger provided the gum pads were kept apart. It seemed that this was related to the spatial relationship of the jaws, the muscular resistance occurring only when the gum pads were within 3 mm. of contact. This mechanism did not disappear until the eruption of the upper and lower first molars.

The author has not, so far, been able to detect any obvious variations of swallowing behaviour much before the age of about 18 months. It is, perhaps, significant that at about this age the child is beginning to use the idle swallow more frequently to dispose of saliva, and the first contact between the deciduous molars occurs. Examination of the film showed quite a wide range of differences of behaviour of the lips during swallowing from this age onwards. In order to assess the significance of these differences, if there is any, it was necessary to attempt to classify them. After a large sample of the film had been examined, a provisional classification was made, dividing the sample into types. Originally six types were identified (*Fig.* 1), but most of these seemed to fall into two main groups, each comprising about a half of the sample.

Fig. 1.—Serial extracted frames of ciné film of six types of lip behaviour during swallowing.

In the first group of cases, which will be called Group 1, the teeth were almost always together at the moment of swallowing, and the vermilion border of the lower lip was visible, there being no tendency for this to slip under that of the upper lip. There was no obvious contraction of the musculature of the lips in 4 cases, the act of swallowing being detectable only by movements in the neck over the larynx (*Fig.* 1 A). Parting of the lips showed the teeth to be in occlusion, and this was confirmed by palpating the contraction

of masseter muscle at the moment of swallowing. No evidence could be found that the tongue penetrated between the upper and lower incisors.

Some contraction of orbicularis oris muscle, as manifested by dimpling at the angles of the mouth, was seen in the remaining 126 cases (*Fig.* 1 B). These children showed no contraction of mentalis muscle. The orbicularis oris contraction lasts $\frac{1}{4}$–$\frac{3}{4}$ sec. On pulling the lips apart the teeth were occasionally found to be parted, but were usually in occlusion at the moment of swallowing, and there was never any visible evidence of the tongue penetrating between the incisors. Almost invariably some contraction of masseter muscle could be felt at the time of swallowing. Of the cases examined in the image intensifier 2 occluded the teeth together, and in 1 there was some doubt. The tip of the tongue appeared in all cases to remain lingually to the lower incisors.

In the second group of cases (Group 2) the teeth were usually apart at the moment of swallowing, and the lower lip passed under the upper at some stage of the swallow. Three types have been identified in this group. The first type, of which there were 74 cases, showed a preliminary contraction of the lower lip with dimpling under the angles of the mouth; this was followed by drawing in of the vermilion border of the lower lip under that of the upper lip (*Fig.* 1 C). After about half a second the border of the lower lip appeared to flip out from under the upper lip, and the musculature then relaxed. Although the contraction appeared to be concentrated gradually, the lower lip escaped quite rapidly. The contraction lasted $\frac{1}{2}$–$1\frac{1}{4}$ sec. There was rarely found to be any contraction of masseter muscle on palpation, and parting of the lips at the time of the swallow usually revealed the tongue lying over the tips of the lower incisors. Ciné X-ray film of 2 cases of this type showed the teeth to be together at the moment of swallowing and the tip of the tongue to be lying above the level of the lower incisors, against the upper incisors. Only 1 of these cases had shown masseteric contraction during the clinical examination.

The preliminary contraction of the lip musculature was both active and prolonged in the second type of Group 2, of which there were 33 cases (*Fig.* 1 D). The lower lip was thrust up under the upper lip, there being obvious puckering of the chin and only a moderate amount of dimpling under the angles of the mouth, that is, mentalis muscle appeared to contract strongly. The lips were difficult to part in these cases, but it seemed that the tongue penetrated between the incisors to oppose the lower lip. Contraction of the labial musculature lasted $\frac{1}{2}$–$1\frac{1}{2}$ sec. Three cases were filmed in the image intensifier; in all of them the teeth were widely apart at the time of swallowing, and the tongue bulged over the tips of the lower incisors against the lower lip. It was noticed that the mandible moved anteroposteriorly just before the swallow, but that it was retracted at the moment of swallowing. This movement may be detected clinically by viewing the patient in profile.

The activity of the circumoral musculature of the remaining 25 cases of this group was not at all marked (*Fig.* 1 E). The lower lip appeared almost to fall behind the upper lip, and there was some dimpling below the angle of the mouth. Occasionally the lips were not brought together, being separated by the upper incisors, which were exposed to view. Usually the teeth were parted at the time of swallowing. The contraction lasted $\frac{1}{4}$–$\frac{3}{4}$ sec. Of 2 cases filmed in the image intensifier, 1 placed the teeth together and the other had the teeth apart at the moment of swallowing. The former case had some masseteric contraction when examined clinically, but the tongue penetrated above the lower incisors.

A further type of swallowing behaviour was obtained in 3 cases only. Here the lower lip was thrust upwards in front of the upper lip, the vermilion border of which was covered (*Fig.* 1 F). This was achieved by strong contraction of mentalis muscle. The lip contraction lasted 1–2 sec. No masseteric contraction could be detected clinically. All 3 of these cases were of prenormal occlusion.

Although the classification of these cases was not at all easy, it was possible to place the

majority into one of these eategories. Some, however, either beeause of failure to reeord an obvious swallow, or beeause they appeared to be intermediate between two types, had to be omitted.

It was notieed when eomparing film of eaeh individual taken at different ages that the types of behaviour remained remarkably eonstant. Although the degree of aetivity diminished, the type of aetivity remained unehanged up to the age of 4 years. After this age, however, some changes of behaviour were seen; most of these were from the seeond to the first type of Group 1. This proeess does not appear to be a sudden one; in most eases the patient alternated between one type and the other.

The stability of the type of behaviour up to the age of 4 would suggest that maturation does not play any part in the establishment of atypieal swallowing behaviour. If this had been the ease migration from one type of behaviour to another would have been expeeted. Certain measurements made on the models have been used to assess the relationship between morphology and behaviour:—

a. The anterior length of eaeh areh was measured from the most prominent part of the areh along a perpendieular to a transverse

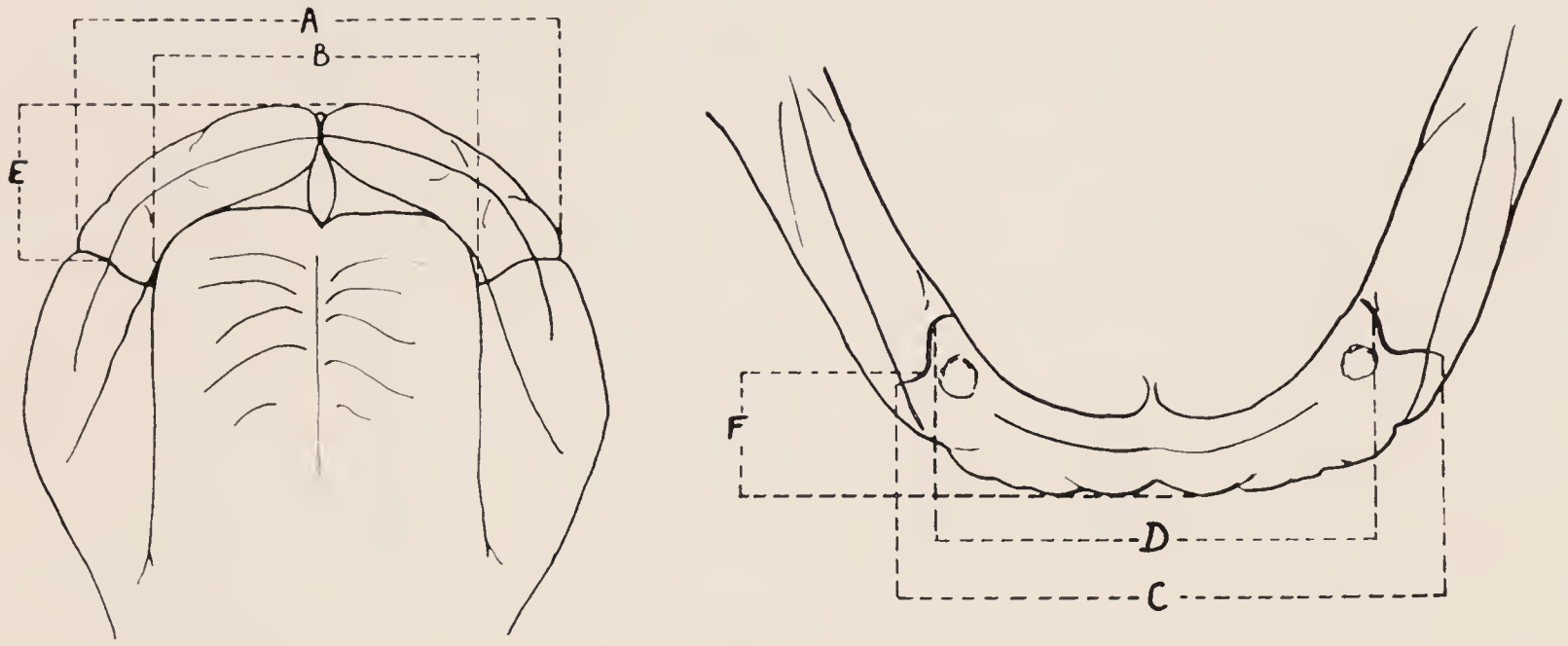

Fig. 2.—Diagram of upper and lower gum pads to illustrate sites for measurement of the anterior length of eaeh areh (E, F).

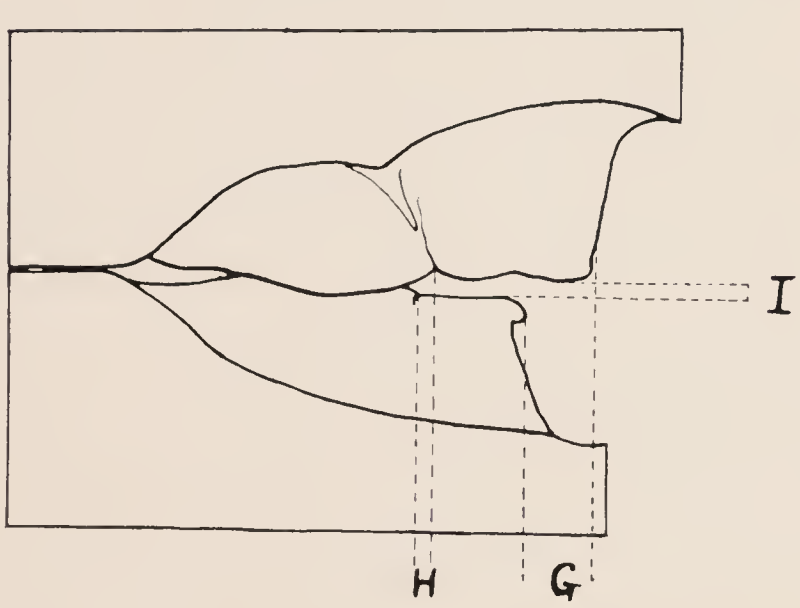

Fig. 3.—Diagram to show the sites of the measurements of the overjet (G), the anteroposterior distanee between the upper and lower lateral sulei (H), and overbite (I).

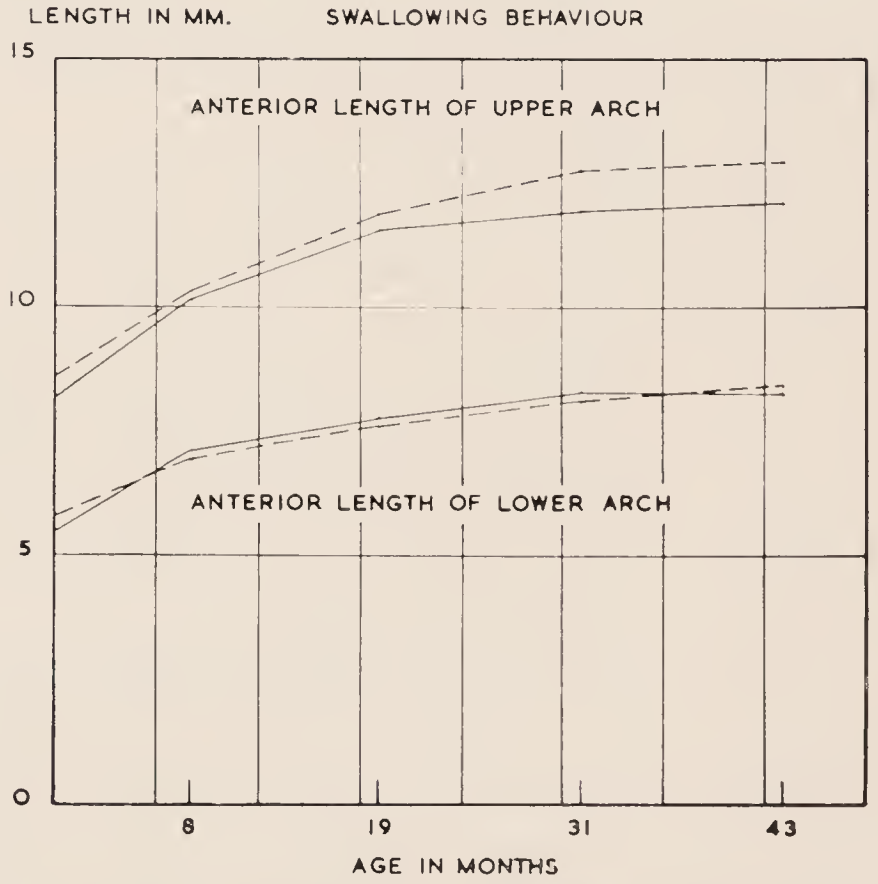

Fig. 4.—Graph to show ehanges of the mean anterior length of eaeh areh with age of Group 1 (eontinuous line) and Group 2 (interrupted line) swallowing behaviour.

line drawn between the points where the lateral sulci cross the crest of the alveolus (*Fig.* 2).

b. The overjet was measured as the horizontal distance between the labial surface of the upper right central and the labial surface of the lower right central. In the case of the gum pads at birth, the most prominent point of each arch was used, and the measurement was made clinically (*Fig.* 3).

c. The anteroposterior distance between the upper and lower lateral sulci was measured as the horizontal distance between the buccal extensions of the lateral sulci. If the lower were distal to the upper it was registered as a negative reading (*Fig.* 3).

d. The overbite was measured as the vertical distance between the tip of the upper right central to that of the lower right central. In the case of the gum pad it was measured between the crests of the upper and lower gum pads in the mildine with the gum pads approxmated. Where the point in the upper arch was above that of the lower it was recorded as a negative reading (*Fig.* 3).

As Ballard has indicated (1952), the thought has crossed the mind of at least one orthodontist that the skeletal pattern at an early age might influence the subsequent development of oromuscular behaviour. At the time that the survey was started facilities for taking lateral skull X-rays were not available. By the time they became so the subjects were between 3 and 4 years old. Lateral X-rays are available, therefore, only from this age. If, as Brodie (1941) suggests, the skeletal pattern

Table III.—Mean Dimensions of the Anterior Length of the Upper Arch, between Birth and 43 Months, of Children divided into Two Groups according to their Swallowing Behaviour
(The measurements in bold type show a Significant Difference at the 5 per cent level)

Age in Months	Group 1			Group 2		
	No. of Cases	*Mean* mm.	*S.E.*	*No. of Cases*	*Mean* mm.	*S.E.*
0	92	8·22	±0·082	91	8·41	±0·093
8	122	10·15	±0·084	122	10·17	±0·081
19	116	11·57	±0·110	119	11·85	±0·126
31	113	**11·99**	±0·109	103	**12·72**	±0·119
43	99	**12·05**	±0·114	83	**12·87**	±0·150
0–43	93	**+3·73**	±0·150	56	**+4·52**	±0·184

Table IV.—Mean Dimensions of the Anterior Length of the Lower Arch, between Birth and 43 Months, of Children divided into Two Groups, according to their Swallowing Behaviour

Age in Months	Group 1			Group 2		
	No. of Cases	*Mean* mm.	*S.E.*	*No. of Cases*	*Mean* mm.	*S.E.*
0	92	5·55	±0·090	91	5·76	±0·092
8	122	6·98	±0·082	122	6·91	±0·084
19	116	7·68	±0·089	119	7·61	±0·080
31	113	8·23	±0·079	103	8·16	±0·092
43	99	8·25	±0·086	84	8·27	±0·111
0–43	73	+2·64	±0·124	57	+2·40	±0·168

remains fairly constant after the age of 6 months, then it may be permissible to use the skeletal relationship calculated at a later age as an indication of the earlier relationship. To assess this the difference between the angles S N A and S N B has been used. This is not entirely satisfactory as a method of estimation, as A and B points lie over the developing permanent incisors at this age. However, it is probably the method least subject to error.

Table V.—Mean Dimensions of the Overjet, between Birth and 43 Months, of Children divided into Two Groups according to their Swallowing Behaviour
(The measurements in bold type show a Significant Difference at the 5 per cent level)

Age in Months	Group 1			Group 2		
	No. of Cases	*Mean* mm.	*S.E.*	*No. of Cases*	*Mean* mm.	*S.E.*
0	122	5·14	±0·135	121	5·44	±0·127
8	122	3·74	±0·176	122	4·12	±0·173
19	116	**3·46**	±0·145	119	**4·25**	±0·139
31	114	**3·04**	±0·132	103	**4·34**	±0·171
43	99	**2·72**	±0·137	83	**4·28**	±0·229
0–43	73	**—2·74**	±0·192	56	**—1·48**	±0·287

Table VI.—Mean Dimensions of the Anteroposterior Distance between the Upper and Lower Lateral Sulci, between Birth and 43 Months, of Children divided into Two Groups according to their Swallowing Behaviour
(The measurements in bold type show a Significant Difference at the 5 per cent level)

Age in Months	Group 1			Group 2		
	No. of Cases	*Mean* mm.	*S.E.*	*No. of Cases*	*Mean* mm.	*S.E.*
0	95	—1·59	±0·158	93	—1·87	±0·135
8	122	+0·11	±0·153	119	—0·31	±0·147
19	117	+1·77	±0·121	117	+1·35	±0·125
31	112	**+2·29**	±0·124	102	**+1·72**	±0·143
43	100	**+2·61**	±0·122	85	**+1·76**	±0·179
0–43	73	+4·27	±0·197	57	+3·84	±0·270

Table VII.—Mean Dimensions of the Overbite, between Birth and 43 Months, of Children divided into Two Groups according to their Swallowing Behaviour

Age in Months	Group 1			Group 2		
	No. of Cases	*Mean* mm.	*S.E.*	*No. of Cases*	*Mean* mm.	*S.E.*
0	122	+0·57	±0·154	121	+0·75	±0·165
8	122	—0·25	±0·143	122	—0·08	±0·145
19	116	+2·40	±0·127	119	+2·46	±0·117
31	114	+2·55	±0·153	103	+2·25	±0·170
43	99	+2·30	±0·158	83	+2·01	±0·215
0–43	73	+2·04	±0·225	56	+1·43	±0·328

Comparison of the mean anterior length of the upper arch showed great similarity between the two groups up to the age of 19 months, after which that of Group 2 tended to increase more rapidly. The difference between the two became statistically significant from 31 months (*see Fig.* 4 and *Table III*).

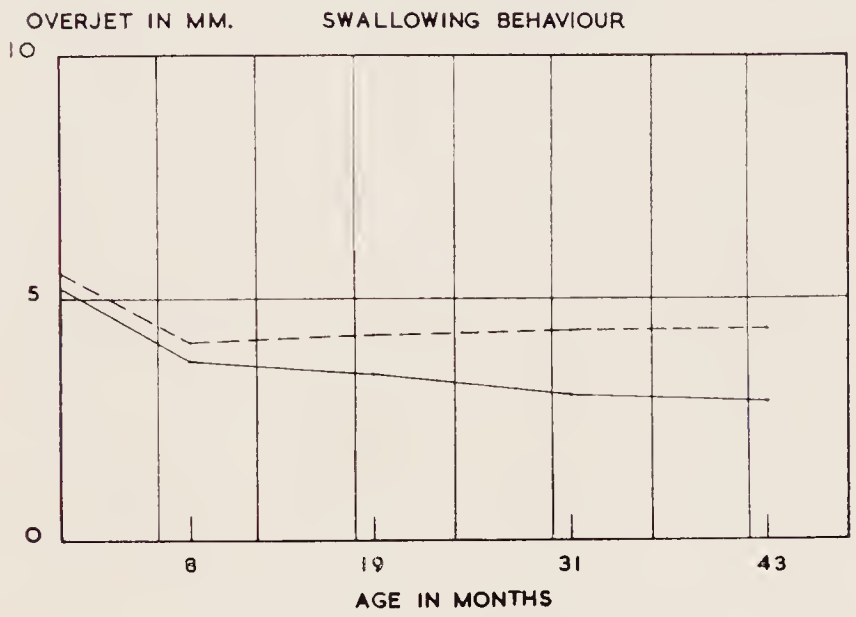

Fig. 5.—Graph to show changes of mean overjet with age of Group 1 (continuous line) and Group 2 (interrupted line) swallowing behaviour.

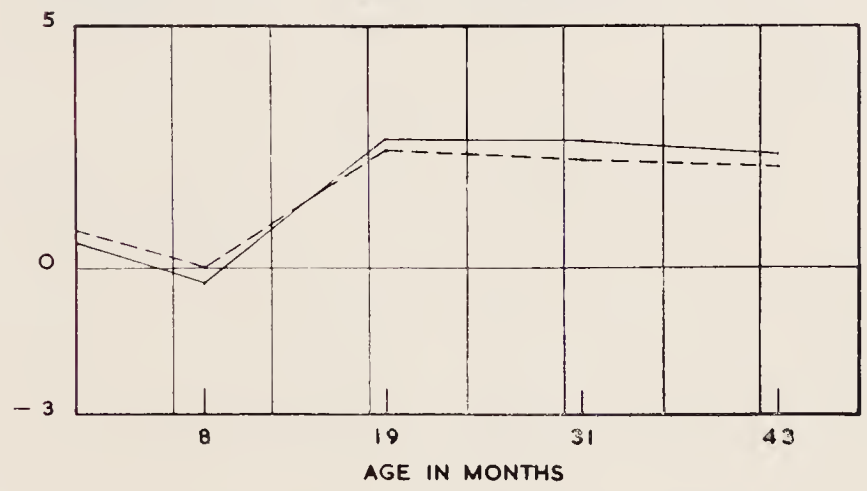

Fig. 7.—Graph to show changes of mean overbite with age of Group 1 (continuous line) and Group 2 (interrupted line) swallowing behaviour.

The corresponding dimension of the lower arch remained the same in both groups (*Table IV*).

The mean overjet was found to be greater for Group 2, the difference increasing steadily from the age of 8 months, and becoming statistically significant from the age of 19 months (*see Fig.* 5 and *Table V*). Although there was a difference up to 8 months, it was not significant statistically. The wide range of overjet seen at birth (2–9 mm. for Group 1, and 2–8 mm. for Group 2) would suggest that this is not an important factor in determining oromuscular behaviour.

A similar picture was reflected in comparison of the anteroposterior distance between the lateral sulci, which was less for Group 2, the

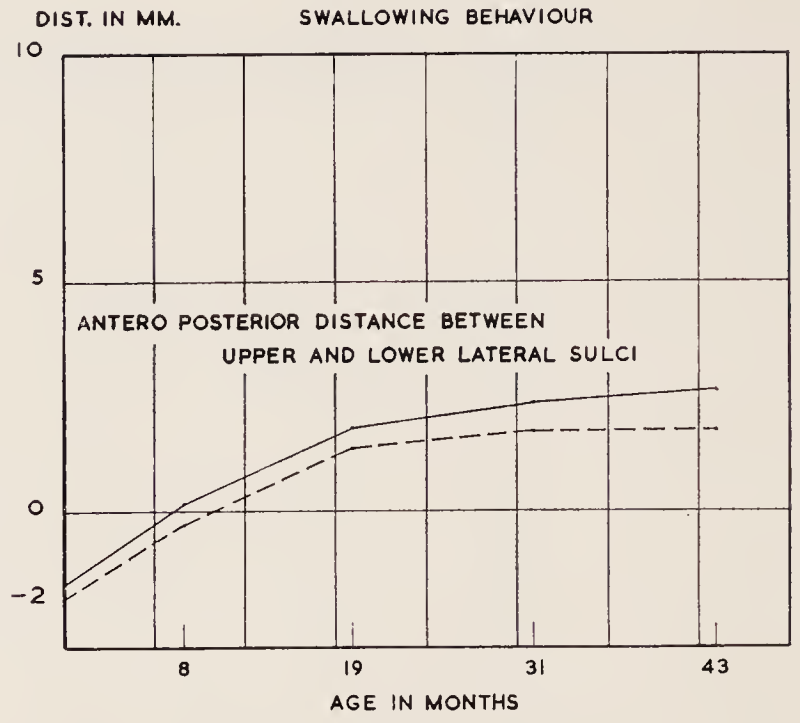

Fig. 6.—Graph to show changes of the mean anteroposterior distance between the upper and lower lateral sulci of Group 1 (continuous line) and Group 2 (interrupted line) swallowing behaviour.

difference increasing steadily with age. This was only significant from the age of 31 months (*see Fig.* 6 and *Table VI*).

The mean overbite was similar in both groups, however, being slightly more at birth but less after 19 months for Group 2 (*see Fig.* 7 and *Table VII*).

Division of a sample into those with and those without masseteric contraction at the moment of swallowing showed similar dimensional differences. The anterior length of the upper arch, overjet, and anteroposterior distance between the upper and lower lateral sulci

Table VIII.—Percentage Incidences of Cases with no Sucking Habit and with a Persistent Sucking Habit among Two Groups classified according to the Type of Swallowing Behaviour

(Cases where Sucking Habits have ceased are omitted. Both differences are significant at the 5 per cent level.)

	Swallowing Behaviour		*S.E. of Difference*
	Group 1	Group 2	
Number of cases	119	119	
Percentage with no sucking habit	43·7	15·1	±5·9
Percentage with persistent sucking habit	24·4	52·1	±6·3

showed only slight differenecs at birth, whieh increasd with age. There was again no statistically signifieant difference of overbite between the two groups.

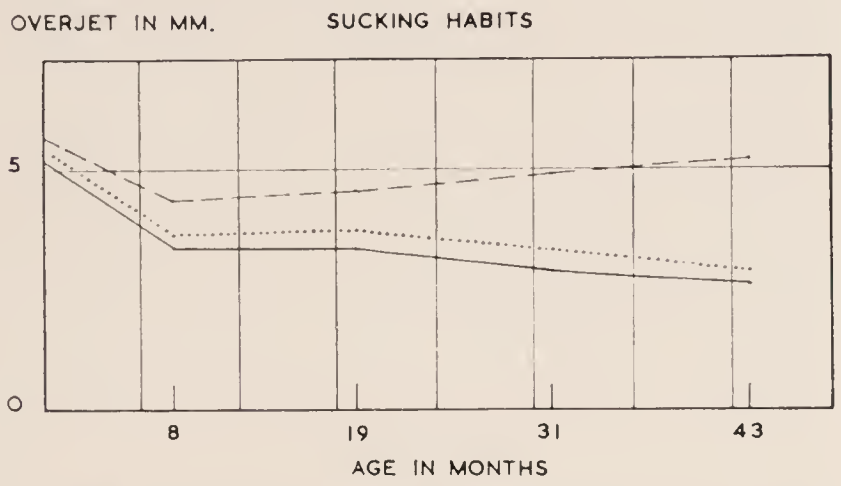

Fig. 8.—Graph to show changes of mean overjet with age of children classified according to the presence of sucking habits. Continuous line represents children with no sucking habit at all, dotted line children who have ceased such a habit, and the interrupted line children with a persistent sucking habit.

oromuscular behaviour. It has already been shown that there was a significant difference of overjet between the two groups of swallowing behaviour by the age of 19 months. Rix, in a letter to the *Medical Press* in April, 1959, wrote: "I have an unconfirmed impression that sucking habits are rather more common among those with underlying conditions which do not foster a close approximation of the upper and lower incisor teeth." Analysis of the incidence of sucking habits among the two groups of swallowing behaviour confirmed Rix's belief that these two conditions are likely to occur together (*Table VIII*).

A glance at *Table IX* and *Fig.* 8 will confirm that where persistent sucking habits occur, there is in fact as early as 8 months a significantly larger mean overjet, the difference increasing with age. There is nothing,

Table IX.—Mean Dimensions of the Overjet of Children with and without Sucking Habits between Birth and 43 Months
(The measurements in bold type show a Significant Difference at the 5 per cent level)

Age in Months	Habit Still Active			Habit Ceased			No Habit		
	No. of Cases	*Mean* mm.	*S.E.*	*No. of Cases*	*Mean* mm.	*S.E.*	*No. of Cases*	*Mean* mm.	*S.E.*
0	91	5·58	±0·157	109	5·32	±0·143	82	5·16	±0·138
8	91	**4·30**	±0·211	110	3·54	±0·182	83	**3·37**	±0·222
19	92	**4·49**	±0·155	106	**3·64**	±0·173	79	**3·30**	±0·163
31	67	**4·93**	±0·208	91	**3·22**	±0·125	65	**2·81**	±0·165
43	54	**5·06**	±0·272	81	**2·80**	±0·163	52	**2·60**	±0·182
0–43	38	**−1·05**	±0·355	54	**−2·20**	±0·220	38	**−2·90**	±0·248

Although no significant differenees of dimension were found between the two groups of swallowing behaviour at birth, there still remains the possibility, as Nord has suggested (1959), that some other agency may have been responsible for a dispersal of the incisors, which in turn induces a particular type of

therefore, in these statisties to indieate that a sucking habit may not at times be the forerunner of certain types of oromuscular behaviour.

Table X.—Mean Measurements of the Difference between the Angles S N A and S N B of Two Groups of Children divided according to their Swallowing Behaviour

Type of Swallowing Behaviour	*No. of Cases*	*Mean Difference S N A–S N B*	*S.E.*
Group 1	64	4·09°	±0·227°
Group 2	60	5·13°	±0·250°

This eannot, however, be put forward to explain the origin of the majority of Group 2 types of swallowing behaviour, beeause the

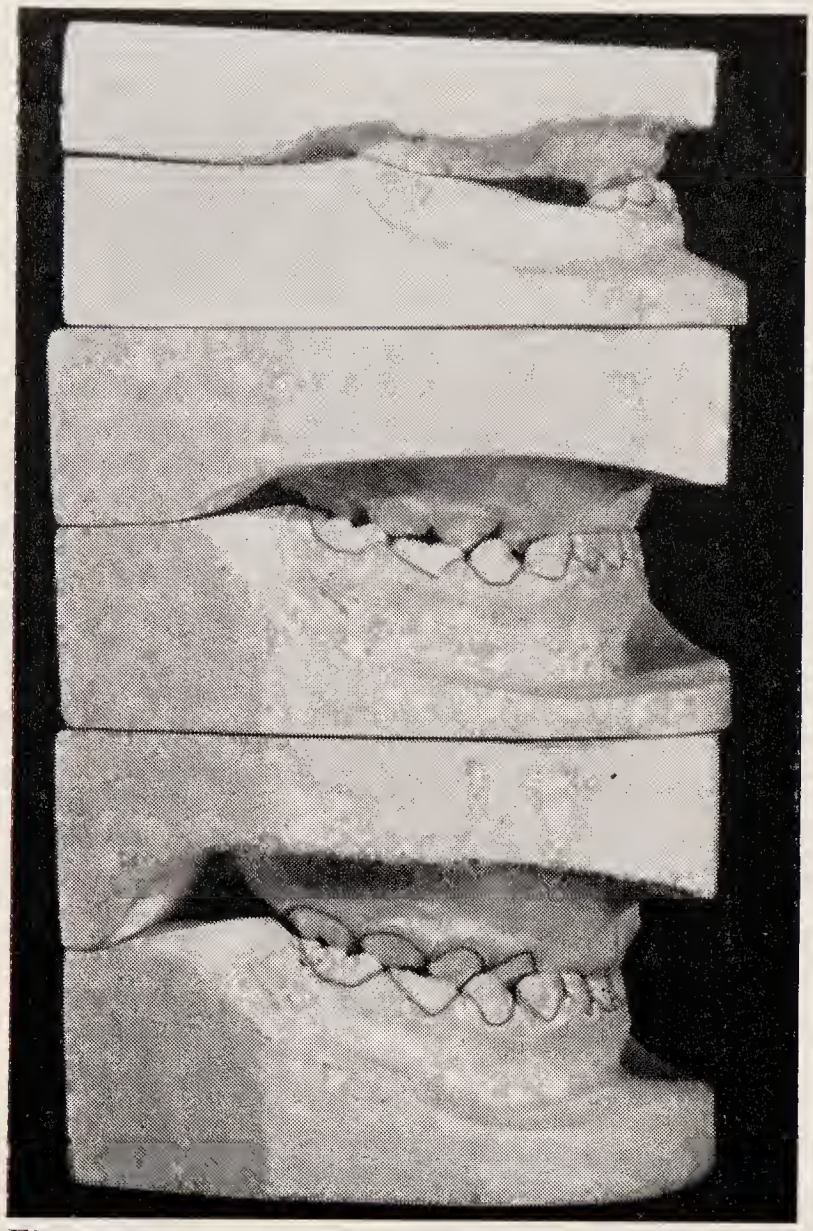

Fig. 9.—Serial models of the case shown in *Fig.* 1 F.

distribution of overjets is so similar in the two groups.

The occurrence of 3 prenormal cases with a type of swallowing behaviour peculiar to themselves suggests that there is a relationship between prenormality and this type of behaviour. Because these cases formed only a minority of prenormal cases, of which most belonged to Group 1 swallowing behaviour, it cannot be claimed that the incisor relationship alone is responsible for the behaviour. However, although no X-ray evidence is available the author had the impression that all these cases were skeletally more prenormal than the others. This is suggested by the models (*Fig.* 9) of the last case shown in *Fig.* 1. Of the remaining 7 prenormal cases, which belonged to Group 1, 3 improved spontaneously (*Fig.* 10), and were, therefore, probably only mildly prenormal.

The mean differences between the angles S N A and S N B are shown in *Table X*. Although the means for Group 1 and Group 2 differ by only 1° this is just statistically significant at the 5 per cent level of probability.

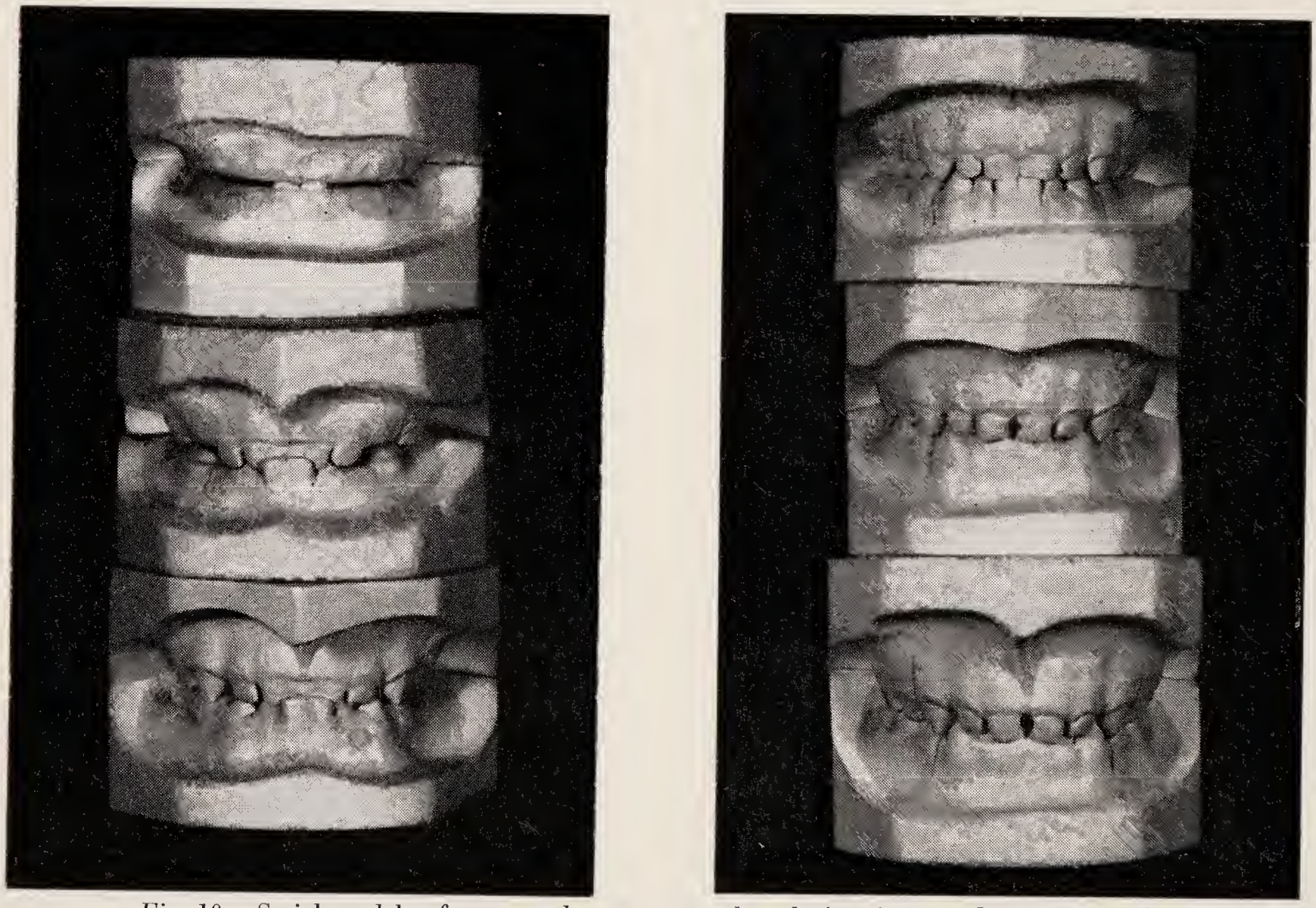

Fig. 10.—Serial models of a case where prenormal occlusion improved spontaneously.

This association, albeit not a strong one, does suggest that skeletal morphology may sometimes influence oromuscular behaviour. However, this cannot be put forward as being of great significance, since the distribution of individual measurements was not dissimilar in the two groups.

By and large, therefore, this analysis points to the conclusion that behaviour of the orofacial musculature is usually determined independently of skeletal morphology, tending to precede rather than to follow those changes that later become associated with it.

SUMMARY

An attempt has been made to identify differences of oromuscular behaviour at an early age by following a sample of children from birth. The difficulties of achieving this have been discussed. It would appear that the most satisfactory method of assessment would be based on an analysis of ciné X-ray film. However, economic difficulties and the hazards of radiation have prevented this approach on a sufficient scale so far to obtain conclusive information. Using ordinary ciné film, some variations of lip activity during swallowing have been shown to exist from the age of $1\frac{1}{2}$ years. A provisional grouping of some of these types has been used as a basis for a statistical analysis of certain dimensions. The stability of types of behaviour between $1\frac{1}{2}$ and 4 years of age suggests that differences of maturation rate do not account for the appearance later of "infantile" swallowing pattern. The similarity of both means and ranges of dimensions of relationship at birth between the groups lends support to the thesis put forward by Ballard that patterns of oromuscular behaviour are probably endogenous, arising independently of skeletal morphology in most cases.

Acknowledgements.—A work of this type cannot be undertaken without a considerable amount of help from others. The author owes his first debt of gratitude to Mr. J. H. Peel, Director of the Department of Gynæcology and Obstetrics at King's College Hospital, and his staff, who went to so much trouble to provide access to the babies at birth. Thanks are due to Professor R. Cocker and Professor K. P. Liddelow for much help and encouragement with the preparation of the ciné film. To Dr. I. MacLaren, Director of the X-ray Department at St. Thomas's Hospital, the author owes a great debt for providing access to the image intensifier and help in taking the films. The author bears a special debt of gratitude to Mr. D. J. Britten, who undertook most of the statistical analysis. To Mr. W. J. Tulley the author will always be grateful for reading the proofs of this paper and for offering much helpful advice. Finally, without the loyal co-operation of the parents of these children, who have been brought through all weathers for examination, the survey would have petered out; to them and their children is owed the greatest debt of all.

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DISCUSSION

The President thanked Mr. Leighton for his most interesting paper. It had been a feat of co-ordination in the method of presentation with the slides, as well as the films. All knew what an enormous problem was posed from the beginning for anyone engaged in longitudinal studies, and the author was to be congratulated on his courage in attempting such an enormous task. He invited Mr. Rix to open the discussion.

Mr. Rix said they had listened to a paper involving a great deal of patient work in a relatively neglected period of life, and the three questions which Mr. Leighton had posed for himself were important. First, was the mode

of swallowing secondary to morphology? Secondly, were variations in the mode of swallowing merely maturation delays? Thirdly, were they inherent, genetically determined, and independent of time and morphology?

Although he had been asked to open the discussion, he had not many bones to pick with the author, but there were one or two points which he would make. The author had said that gum pads were difficult to approximate by 6–8 months. A finger would be gripped yet a resistance to further closure would be put up within 3 mm. of contact of the gums. He had said that this mechanism did not disappear until the eruption of the first deciduous molars. Would Mr. Leighton be prepared to accept an alteration in phraseology here which would better interpret the mechanism? Would it not be feasible to say that the mechanism did not in fact disappear but that the occlusal rise of the first deciduous molars continued until this resistance dimension was obliterated?

The swallowing behaviour did not show obvious variation before 18 months. Thereafter the youngsters were put into two main groups, and it so happened that the groups were about equal in numbers. Half showed no activity or a little activity of the lips, and the teeth were almost invariably in occlusion. In the other half there was more lip activity and the teeth were usually apart, with the tongue lying over the tips of the lower incisors.

In this second group three types of behaviour were distinguished. In the first group there were two types. He would have been happier if these five types had not been lumped into two groups. There was perhaps a temptation to form groups which were large enough to reduce the inquiry to a statistical exercise, but more would have been learned in the end if the types had been kept very exclusive and discrete. He hoped that Mr. Leighton would give them another paper in ten years' time on a longitudinal study of these various types. If, however, they accepted his two main groups as broadly representing swallowing behaviour—and he thought they could—the co-relations which the author had found were most interesting.

He noted that the digit suckers were more numerous in Group 2. There was just over a 50 per cent chance of a habit being present if a child were a Group 2 swallower. One could not argue that the Group 2 swallowing behaviour was a result of the sucking habit, and the whole analysis pointed to the conclusion that behaviour was usually determined independently of skeletal morphology. There was also the point that there was a certain stability of behaviour and that maturation in the period investigated had brought to light very little fundamental change. Occasionally in later years, in the later 'teens, he had seen changes of a fundamental character, the last being a Class II, division 2 which had been treated; here the teeth had not originally been together when swallowing, but finally they had been together. In treated postural Class III cases he would have thought that a similar change might sometimes be seen.

They had seen an interesting shifting of the mandible in the image intensifier X-ray shown by the author, but he wondered whether this was related to swallowing. If you had chocolate glued to the roof of your mouth you would try to remove it by anteroposterior movements of the tongue, and these would tend to rock the mandible backwards and forwards. One must be very careful before ascribing these movements to preliminary swallowing movements.

He congratulated Mr. Leighton on his tenacity over the years in seeking answers to most important questions and on throwing more light on those early years which had remained in the shade for so long.

Mr. Tulley also congratulated Mr. Leighton on his work. He had seen some of the effort which had gone into the paper. The attempt to use ciné X-ray films was worthy of special commendation.

He had no questions to ask, because he had already asked them privately. He had found that in looking at the films for the first time it was difficult to distinguish the detail of the swallowing behaviour. One always found in filming children that a great deal of idle lip activity went on all the time. Those members who had just seen the films for the first time could not distinguish these details as easily as could Mr. Leighton, who had lived with the films and could see much more in them.

The value of the work would be seen when the children began to change their dentition and when one could see the environment affecting the erupting incisors. He hoped that Mr. Leighton would continue the work with the same vigour and would not lose too many of his patients—because that was the difficulty with long periods of study.

Professor Ballard congratulated the author on his painstaking work. There was not much one could say about the investigation except to wish him luck in not losing more of the children before they reached the stage when their permanent dentition had erupted. He hoped that even then Mr. Leighton would not be disappointed if he found that the majority of them had normal occlusion! Statistics suggested that they would.

Although they thought that soft-tissue behaviour was developed independently of the skeletal morphology, it had to be adaptive, and it was because it was adapted that with extreme variations of morphology normal occlusions could occur.

From the point of view of clinical experience, however, it is important to realize that it is only endogenously adaptive. Permanent adaptations could not be induced by exercising or conscious effort.

Mr. Gwynne-Evans said he was grateful to Mr. Tulley for asking him to join the meeting. With Professor Ballard and Mr. Tulley, he had spent many years working on these problems. It had given him pleasure to hear Mr. Leighton's paper and his review of past work. It was important that we should understand more about how much behaviour was innate and how much was adapted or acquired through environmental contacts, because a dogma was emerging from work in other fields, viz., that nothing short of a genetic process could alter a genetic pattern whatever that pattern may be. He congratulated Mr. Leighton on his address.

Miss Clinch also congratulated Mr. Leighton. She realized the amount of work which had gone into the paper, but it was a consolation to feel that oromuscular behaviour was not as important as they had recently been led to believe. Obviously the majority of these children would have a normal occlusion. They were an unselected group, and it would still be found that there was more good occlusion than malocclusion in an unselected group.

Had Mr. Leighton any evidence about the position of the tongue? She knew that the tongue was between the pads at rest. It was her impression that there were some cases in which the tongue remained between the teeth at rest. Had Mr. Leighton noticed that in any of these children?

It was always difficult to know clinically whether the teeth were together when swallowing occurred, and she was consoled to learn that the author had also found this difficult. It was simple to write, "Teeth together at swallowing", or "Teeth apart at swallowing", and it was very tempting to do this, but she doubted whether it was always accurate.

Did Mr. Leighton think that there was a fixed position at which the upper and lower gum pads occluded or met, rather than a condition similar to that of an edentulous adult?

Mr. Wilson endorsed all that had been said about Mr. Leighton's work. Some of those speaking in the discussion, however, had been speaking of morphology when they meant behaviour, which the author had been studying; morphology was something entirely different and might be studied in a continuation of his work. Morphology of the tongue was probably more important in some of these cases than morphology of the lip muscles.

The author's graphs had given a clear picture, but would they not have given a more accurate picture in the form of scattergrams? These would have demonstrated that the types were not as far apart in some cases as might be believed from the graphs and that one group would evolve into the other.

Illustrations often tended to remain in the memory longer than the spoken word. This overlap which occurred would therefore have been better illustrated by the use of scattergrams.

Mr. Leighton, in reply, said that he had expected to be pulled to pieces in the discussion. He thanked Mr. Rix for his kind remarks. He gathered that when Mr. Rix said that the first molars moved up into the space as they erupted between the gum pads, he implied that the occlusal level rose. He could offer no opinion on that; his feeling was that the children were willing to bite on teeth or on an object but were not willing to bite their two gum pads together. It might be because it overclosed the mandible or it might be that a defence mechanism prevented them from biting themselves.

In drawing attention to the division of these types into two large groups Mr. Rix had put his finger on the one weakness of this classification. It had been necessary to have reasonable numbers for a statistical analysis. The division of the sample into the six original types would have left the types with so few numbers that nothing could be learned from them. The division into groups had been merely a working hypothesis and had not been intended as final. It might be revised as the children grew, but it had been necessary to start with a simple classification in order to study the children statistically.

Mr. Rix had mentioned that some children might change their behaviour later in life. The cases which he had mentioned, however, had been treated cases, not untreated. A change of behaviour without being stimulated by a change of environment probably did not occur.

The rocking of the mandible shown on the X-ray had been a preliminary peculiar to cases in the second group, and they had practically all been in that second type in the second group. It had not been seen in any other cases, even before they swallowed.

He agreed with Mr. Tulley that the types were difficult to distinguish, and when playing a film straight through he himself had had great difficulty in determining the different types. The only satisfactory way was to put the film into an "editor" by which it could be run backwards and forwards as often as necessary and studied frame by frame.

Professor Ballard had expressed the belief that most of these cases would become normal. He sincerely hoped that this was right and he would not be in the least disappointed if it were; because if it were not, there was a threat that all these cases would descend on him for treatment! If he had to treat them all, it would completely ruin his research.

He had no doubt that behaviour was adaptable to morphology, but his general impression was that morphology was not the controlling factor in determining behaviour. Behaviour was developed independently of morphology and morphology was perhaps thrust upon it.

He took issue with Mr. Gwynne-Evans in the suggestion that these behaviour patterns were genetic; he had not said that at all. He had said that they were developed independently of morphology, or so it appeared. To decide that they were genetic required an altogether different study. It must be based on a study of parents of children or twins.

Miss Clinch had asked whether the tongue was between the teeth in any of the cases. He could not say whether this was so. It was difficult in young children to move the lips without disturbing everything. Immediately you approached a child with the hand, the mouth opened, because they found that the children were so well trained, and you could see nothing but teeth. It was very difficult to study children in their rest position. The only solution was to take X-ray pictures without touching them. The gum pads at rest could be placed in the same relationship repeatedly; it did not seem to vary provided that you did not exert any pressure backwards or to one side. It was possible by varying the direction of pressure, especially if it were excessive, to produce almost any sort of relationship you chose. Provided that you used gentle pressure upwards and had them completely relaxed, it was possible to repeat the same relationship time and time again. It did not seem to vary. At that age the mandible was rather mobile and rather soft, and it was possible to bend all the tissues if you used excessive force.

Mr. Wilson had asked about the morphology of the tongue. The author had made no attempt to study either the morphology or the position of the tongue at rest. The lateral X-rays were available, and the information was available, as far as it could be obtained from lateral X-rays.

He must justify his use of graphs. These were supported by statistics, but he had spared the audience these. He had been advised that orthodontists did not like figures! If a statistical analysis were made of these figures and standard errors were calculated for each of the means, it was possible to indicate the amount of variation above and below each mean. By doubling the standard errors and taking the sum of two adjacent ones it was possible to determine whether the difference was statistically significant. This was what he had done. Scattergraphs or scattergrams showed quite well what he wanted to explain, but they could not be subjected to mathematical analysis and it was impossible to say whether what was seen on the graph was the result of chance or was a real difference.

He thanked those who had contributed to the discussion for having been so kind.

The President said there had been some hesitation to take part in the discussion at the beginning, not because people were not interested—they were very interested—

but because this was a problem of many facets on which they required time to reflect. They would look forward to seeing the paper in print. The author had made a courageous attempt and they hoped that he would continue his work. If Mr. Tulley were still Editor in 1969, no doubt he would arrange for Mr. Leighton to give another paper about his conclusions on these children, still munching their chocolate to the age of 14—if their teeth had not disappeared through caries by then!

He hoped that the author's studies would not go the melancholy way of so many statistical studies and that by then he would find he had only 2 cases left, one being normal and the other abnormal!

He was sure that the audience would join with him in proposing a hearty vote of thanks to Mr. Leighton for all the time and trouble he had given to the careful presentation of such an interesting paper.

The vote of thanks was carried with acclamation.

GENETICS AND CLINICAL RESEARCH

By **H. KALMUS**, M.D., Sc.D.

I AM greatly honoured by your invitation to deliver the Northeroft Leeture, 1959. I suppose the invitation to do so was extended to me in full knowledge of my complete innoeence as far as orthodonties is eoncerned, possibly with expectations that I might provide some amusement. However, by choosing my theme near my main interest whieh is geneties, I hope to be on reasonably solid ground. Whcn approaching your special interests, which I can only do to a limited extent, and by way of an example, I shall also touch another of my interests, namely, the study of behaviour.

Some of you may have attended a lecture by Professor Grüneberg in 1949 (Grüneberg, 1950), on a theme similar to mine, and may notice a certain overlap in our treatment. Nevertheless, so much has happened in the last decade that my leeture may be justified.

A few words eoncerning contemporary genetics may be in order. Some thirty years ago genetics appeared to most outsiders as a rather statie discipline of a severely formal type in whieh living organisms were represented by mathematical symbols. Genes seemed to bc immutable and pcrmanent like the atoms a hundred years ago. And this study appeared highly academic and almost irrelevant to the pursuits of doctors and research workers, who just then were most sueeessfully engaged in gaining control of sueh environmental forees as the infeetious agents or the vitamins. The situation has now changed rather radieally: mutation, whether spontaneous or indueed by radiation or chemieals, has transformed geneties into a dynamie science. The bioehemieal nature of gene aetion has brought our science into the centre of contemporary physiology and the very mathematies of population geneties have become alive and eoneerned with evolutionary changes. At the same time the successes of environmental manipulations by the doetor have demonstrated the existenee of numerous genetical eonditions which must be approaehed in a novel way. In addition, there are such striking novel discoveries, showing that mongolism and Klinefelter's and Turner's syndromes are eaused by chromosome anomalies; or that leukæmia may show somatic ehromosomal aberrations.

The relations between genetics and clinical researeh, which are of many kinds and fairly eomplex, can be unravelled in different ways. Considering them as relations between people trained in different disciplines, we might, for instanee, ask in what way ean geneticists and elinicians eo-opcrate in their pursuits. In the medical, dental, or veterinary eurriculum genetics are taught only in the pre-clinical and sometimes evcn in the pre-medical phase of instruction, usually by a non-genetieist, for instanee by an anatomist or physiologist, zoologist or botanist, who, though he may have some sound knowledge of the fundamentals of Mendelism, can by the nature of things have but little first-hand elinieal experienee. Thus there is need to supplement such fundamental instruction later in the eurrieulum, for instance in the pathology course or some clinieal eourses; if the teaehers eoneerned feel diffident about their genetieal knowledge they should eall in a human genetieist to give a few lectures. If these are properly integrated they can provide the basis for prolonged eo-operation, to the ultimate benefit of the patients. From the genetieist's point of view co-operation with the practitioners of medicine or dentistry is, of eourse, most valuable, as they are the foremost source of the material for his studies. But the doctors can also profit; busy elinieians have little time and their genetics tend to beeome rather obsolete; also they may sometimes not realize to what extent genetieal investigation may help in their diagnosis, therapy, and eounselling.

One way in whieh doetor and genetieist may eo-operate is to use hereditary conditions in

The Thirteenth Northcroft Memorial Lecture given at the meeting held on November 9, 1959.

animals as models for similar human conditions (Grüneberg, 1947). Obvious advantages of such a procedure are that one can manipulate the breeding of animals, producing large numbers of "patients"; that one can investigate the individuals in many ways in which one cannot handle humans, and that one can kill them; another great advantage is that a stock of laboratory animals usually contains only one and the same hereditary condition, which means that one is dealing with a "pure" disease. One can rarely be sure of this in clinical investigations. Anomalies like pigmentary defects, skeletal malformations, muscular dystrophy, and endocrine disturbances have been profitably studied in animals. In the end, of course, such studies must revert to man.

In other cases, direct and immediate studies of hereditary conditions in man are often more advantageous and, in fact, sometimes the only possible way. This is fairly obvious in conditions affecting mental aptitudes and other higher faculties. But it also applies to such conditions where biochemical analysis is furthest advanced in man or where rather larger amounts of material are needed for research than can be conveniently provided by the smaller laboratory animals. Finally, the population aspects of genetics are best studied on human material as demography and case histories provide more detailed information on great numbers of people than are available for individuals of any other species.

Clinicians are interested in diagnosis, aetiology, prognosis, therapy, and prevention, and I think that this audience might like to hear some ideas of a geneticist concerning these five points.

DIAGNOSIS

Most, but not all, genetical diseases are characterized by familial occurrence, either in successive generations or in sibships. But infection or malnutrition can, of course, also run in family groups and on the other hand

Table I.—Time and Factors which might affect a Clinical Condition of an Adult

Time:	Before conception	During meiosis and fertilization	Embryonic period	Fœtal period	During birth	Childhood and adolescence
Factors:	Gene mutation in germ plasm of parents or earlier ancestors	Chromosomal anomalies: loss, non-disjunction, translocation, unbalanced recombination	Maternal physiology (age), infection, rickets	Uterine infection; Maternal–fœtal incompatibility	Birth injury	Diet, infection, accidents, social condition, medical treatment

dominant mutants causing death or sterility are not likely to spread. Therefore, other additional criteria must be frequently used: for instance definite Mendelian ratios, in all dominants or recessives; consanguinity in rare recessives; sex linkage in sex-linked recessives, like hæmophilia or osteochondrodystrophy (Morquio's disease); paternal age at conception in lethal or sublethal dominants. Heterogeneity of the clinical material, imperfect manifestation, difficulties of selecting adequate control groups, the existence of phenocopies, i.e., non-genetical mimics of hereditary conditions, must frequently be taken into account (Kalmus, 1957). In spite of these difficulties and several others which make human genetics a rather forbidding subject, new human hereditary conditions are being constantly discovered, especially in the biochemical field and in serology.

AETIOLOGY

The idea that diseases need not always be caused by extraneous agents, such as bacteria or trauma, but may be traceable to a faulty blue-print for development, or as we would now say to faulty genetical information, was

first clearly conceived by Garrod (1908), who applied it to the inborn errors of metabolism. But it applies equally to the development of malformation or to defective higher functions.

It should, perhaps, not be necessary to mention that the terms hereditary and congenital are neither synonymous nor interchangeable. The first refers, as just mentioned, to a faulty plan, the second to the fact that a condition becomes visible immediately after birth. *Table 1* illustrates the phases of life at which various noxious agents may cause disease.

PROGNOSIS

Many doctors are inclined to consider hereditary diseases as particularly intractable and almost beyond the scope of therapy. Now, it is true that a fault in the construction of a machine might be so fundamental as to be incurable; but so is many a breakage. On the other hand, it is often possible to offset some defects in construction, for instance by special manipulation or by reducing the strain. Thus we might guess that there is no intrinsic reason why therapeutic measures should not succeed in many hereditary conditions—as indeed they have in diabetes or cataract—and that our relative impotence in the field is mainly due to previous neglect.

THERAPY

An ideal therapy of a disease caused by a mutant gene would, of course, be the removal of this gene from every nucleus of the patient's somatic and germ cells and its substitution by the normal allele; alternatively one could try to "repair" the gene. I should say such procedures are unlikely ever to succeed. Therefore, palliative therapeutic measures must be resorted to. We have already stated our opinion that ample scope exists in this direction.

PREVENTION

One can try to prevent genetical disease on the levels of the individual or of the population. Early diagnosis will sometimes enable the doctor to prevent the damage which a genetical situation would otherwise cause. In this, genetical knowledge may be of considerable help. An example is erythroblastosis fœtalis, the dangerous jaundice of the newborn usually caused by maternal–fœtal incompatibility. If one or several births of a woman have produced jaundiced babies, one should—after serological investigation—be prepared for speedy blood transfusion after any subsequent delivery. Thousands of lives have already been saved in this way. Perhaps it should be mentioned that these children are not by any stretch of imagination pathological. They are Rhesus-positive (most of them carry the gene D), as is the majority of mankind; their misfortune is that they are borne of Rhesus-negative mothers, who themselves do not show any sign of disease either.

The prevention of genetical disease in populations is a difficult and thorny problem. We might distinguish between the appearance of new deleterious mutants and their spread. Very likely mutations of many kinds occur all the time at rather low frequencies. It is possible that their rate is increased locally or by certain new man-made agencies. But, as yet, we know rather little about the effects of radiation and chemicals on human mutation rates, except that they are difficult to discover.

Methods devised to limiting the spread of existing noxious genes may be called "negative eugenics". They are but rarely applicable or effective. The proposition usually is in the nature of spilling the child with the bath water, i.e., one tries to remove the disease with its carrier be it by killing, aborting, or sterilizing. Slight hereditary defects will not easily induce a doctor to such drastic measures, and genes causing severe defects will, as a rule, either be self-eliminating (when dominant) or inaccessible (as in recessives), where the majority of the genes is carried by normal heterozygotes and their presence usually cannot be ascertained with certainty.

I have so far tried to draw the outlines of human genetics and their clinical application. You may ask whether any of these have a bearing on orthodontics. I should think connexions exist and thus will discuss part of this your field, namely certain types of malocclusion.

[My feelings in this venture may, perhaps, be compared to those one of you might experience if called upon for the first time to perform some jaw operation on a lion. You would probably tell yourself that everything is likely to proceed quite orderly and politely, and you might think of the reasonable fee for

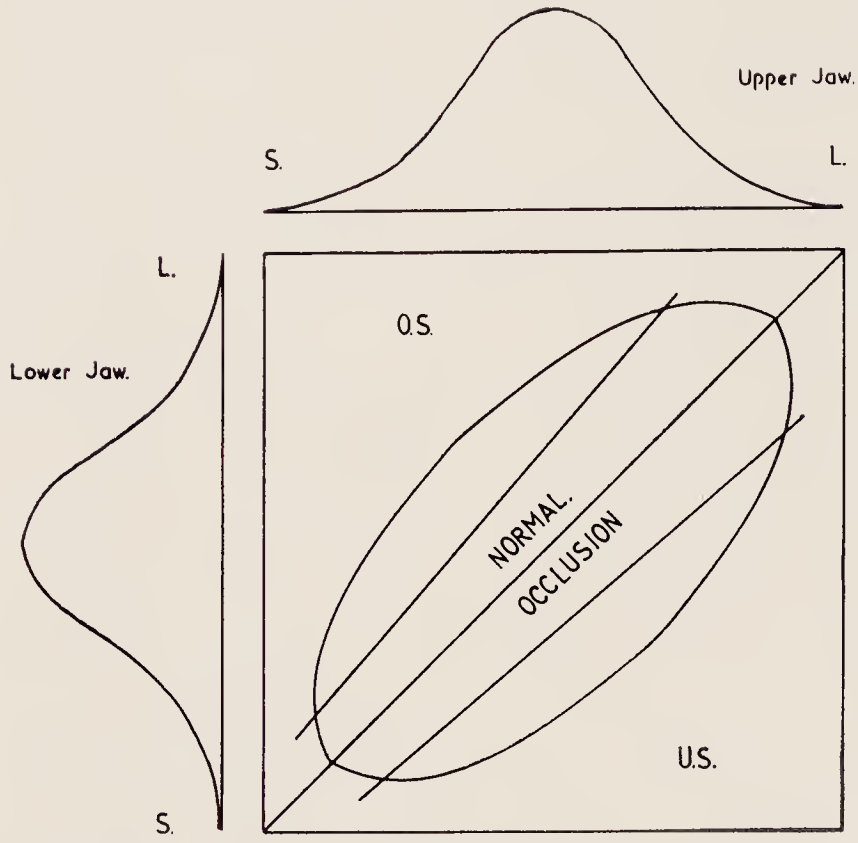

Fig. 1.—The lengths of the jaws of people in relation to dental occlusion.

your efforts. On the other hand, an apprehension of certain disagreeable possibilities is bound to well up in your mind. Now I do not want to exaggerate by adding to the fearfulness of my situation except by saying that most of what I am going to say will look at me from the printed page, and that can be a very cold stare.]

Let us make a start by considering what we mean when calling a person or condition "normal".

The word "normal" is used in everyday language, and has a great variety of meanings. It is, perhaps, most widely used in the medical sense, when it means "not ill". Doctors have for centuries tried to define normality more positively, but it still remains a rather negative concept. In law, too, a concept of normality is used which may be equated to some extent with sanity or responsibility for one's actions. Another aspect of normality is the statistical one; a normal or average person defined statistically will fall in certain of his measurable characters between arbitrary limits on both sides of the most frequent value, that is, within the "normal range". Ever since Quetelet introduced the term "L'homme moyen", the "average man" has haunted public life and social science. Yet another

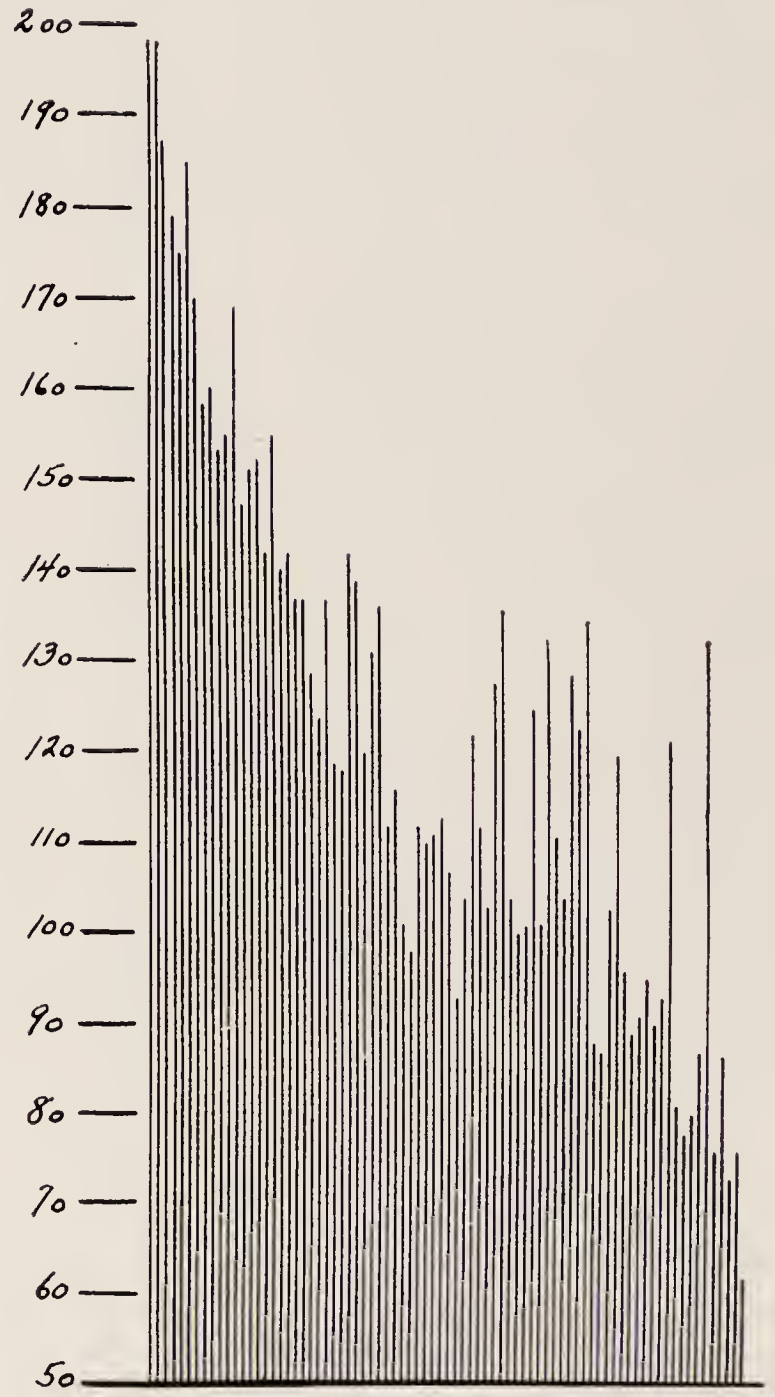

Fig. 2.—The ordinates represent the mandibular lengths of the skulls of dogs, which are arranged in descending order of palatal length. The correlation though positive is quite imperfect. (*From Stockard and others*, 1941.)

application of the word "normal" has at times considerably confused some members of the medical profession. That is, in the term "normal distribution", the usage of which should be discouraged in favour of the term "Gaussian or Bell-shaped distribution". But, as always, when one talks about populations and measurements this aspect, too, will enter our discussion.

I should now like to try to show how to study maloeclusion, making a start from the normal situation. If normal oeclusion consists in an effieient and convenient relative position (eorrelation eoeffieient = 1, as originally defined by K. Pearson at University College). In this situation the points, the x and y's of whieh represent upper and lower jaw length,

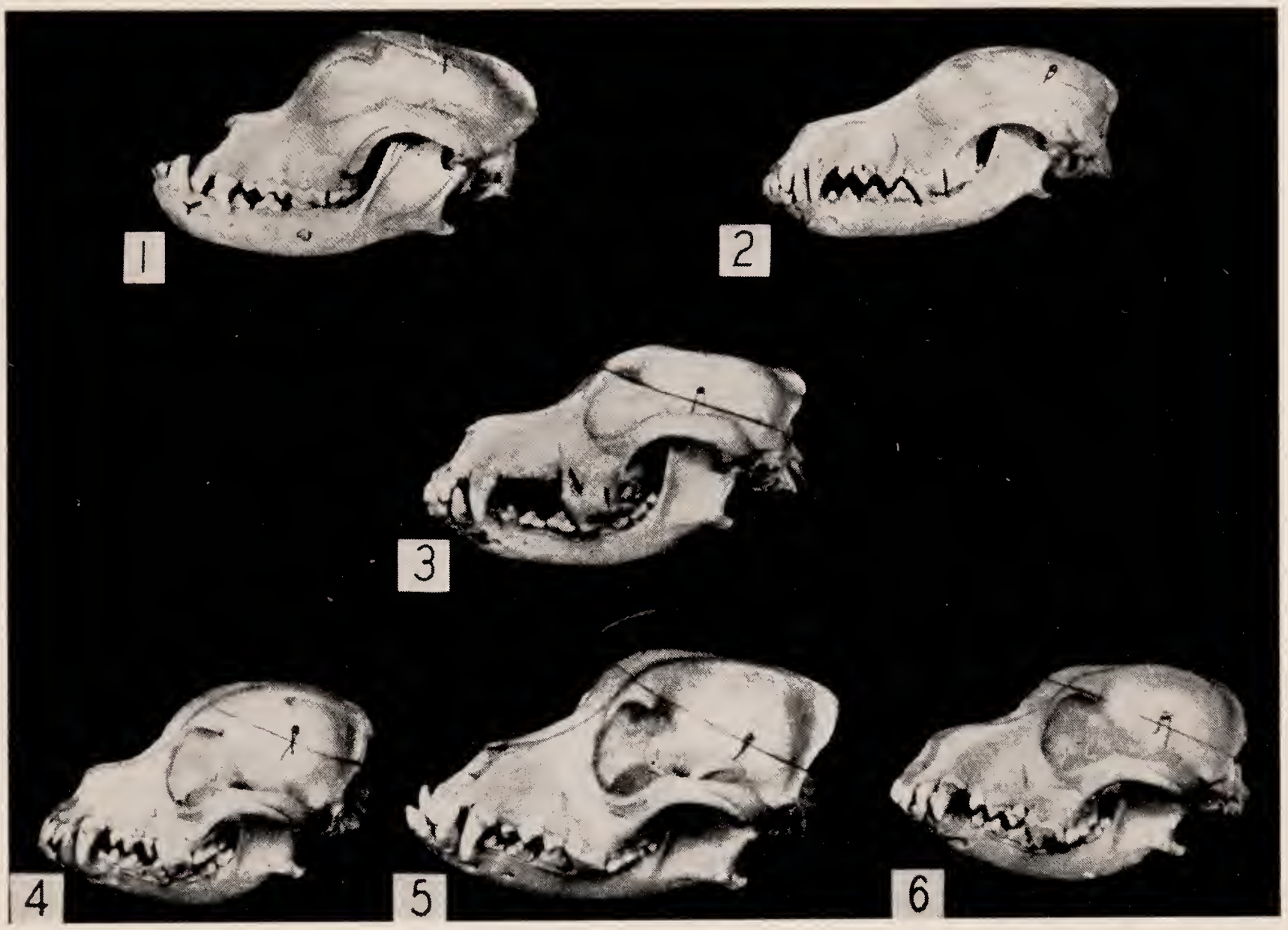

Fig. 3.—Crosses between a French bulldog (1) and a dachshund (2). The F_1 generation (3) shows almost normal dental occlusion, but overshot (6) as well as undershot (5) and near normal occlusion occurs in the F_2. (*From Stockard and others*, 1941.)

of upper and lower teeth, we may assume that the length of any upper jaw and of the eorresponding lower jaw must be sueh that, within the limits of mobility and of eomfort, sueh a position ean be maintained. On top of *Fig.* 1 you see a hypothetieal Gaussian distribution of some measurements of length of upper jaws and on the left a similar distribution of the lengths of the eorresponding lower jaws. [I ean quote a paper on how to measure isolated mandibles, namely one by Morant, 1936, but none on how to measure upper jaws or how to make measurements in the living.] Let us now eonsider what would happen under two extreme eonditions. If the effeetive lengths of upper and lower jaws were always the same we should get perfect eorrelation would fall in the diagonal and there would be no maloeclusion.

If, on the other hand, there would exist no eorrelation between the lengths of maxillæ and mandibles, these points would be all over the plaee and a eonsiderable number of mouths would fall outside the limits set to normal oeclusion.

In reality a fairly high, but not absolute, eorrelation exists between the lengths of the jaws and the points in *Fig.* 1 will mostly fall within an ellipse as indieated; and as a eonsequenee the number of maloeeluded mouths is eomparatively small. Measurements on those lines have been done on dogs (Stoekard and others, 1941; *see Fig.* 2) but have not to my knowledge been published for man.

They would provide information on what one could call "normal occlusion and its aberrations".* Genetically one might suppose that such a situation would be the result of many small and unequal genetical and environmental effects on the growth of both or either jaw (polygenic inheritance); the extreme misfits would then be the outcome of random combinations, and no clear Mendelian distribution would be discoverable in the families and relatives of such people. Eugenic prevention in such cases would be quite impracticable.

Segregation would, however, be expected in all cases where a single genetical difference greatly interferes with the growth of either jaw or of both. Many relatives of a person affected in this manner will have abnormal bites and they would all either have undershot or overshot mouths.

Human families containing members with grossly overshot jaws and others with grossly overshot ones must be rather rare. In dogs (*Fig.* 3), however, litters have been described, mostly in the second filial generation of greatly divergent and rather pathological breeds, which contain a high proportion of undershot and of overshot individuals, indicating, as is thought, a generalized developmental disharmony. One might suppose that such disharmony occasionally occurs in humans in the offspring of two individuals carrying different genes which greatly affect the growth of jaws; but there is no human race corresponding to the bulldog or the basset hound on the one hand, and the alsatians, whippets, and similar breeds on the other hand (*Fig.* 4), and comparable human crosses must be rare; and as most human populations are predominantly composed of well-occluded people, hybrids will, as a rule, not show malocclusion either.

Fig. 4.—Skull bases of an English bulldog (1) and a German shepherd dog (alsatian). In the greatly shortened maxilla of the bulldog the premolars stand crosswise. (*From Stockard and others*, 1941.)

* This descriptive name is taken from a similar study on emmetropia (Sorsby, Benjamin, Davey, Sheridan, and Tanner, 1957).

As most of you will be very familiar with cases of malocclusion in your patients I will not bore you with such examples, but, instead, discuss a few cases of this condition in various animals (*Table II*).

Until now I have dealt with the various instances of malocclusion as if they were entirely a matter of bone growth and quite independent of innate posture patterns (Gesell, 1942, 1954), of oral habits, and their individual development. Now as Ballard (1956, 1957) has pointed out, attempts at changing the innate behaviour and posture patterns of the mouth are alone quite ineffectual

Table II.—Hypothetical Sequence of Events affecting Various Kinds of Malocclusion

Genetical Situation	First Discernible Gene Effect	Sites	Secondary Effects	Effect on Jaws	Position of Teeth	Species	Author
"Screw tail" a recessive autosomal gene	Probably general mesodermal growth deficiency of axial skeleton, etc.	Axial skeleton, skull, jaws, teeth	Many, generalized severe, stunted animals	Shortening of ramus of mandible	Lower incisors greatly backwards. Tend to curl up	*Mus musculus*, etc. (mouse)	MacDowell, Potter, Laanes, and Ward (1942)
Homozygous autosomal lethal	Anomaly of cartilage	Nose, snout, trachea, thorax, etc.	Many, generalized severe, stunted animals	Upper retarded (undershot)	Incisors edge-to-edge, or lower in front instead of upper in front	*Mus norvegicus* (rat)	Grüneberg (1938)
Several alleles, one semi-dominant	Perhaps chondrodystrophy	Head, long bones, spine	Hydrocephalus ? Many others	Shortening of upper	Upper incisors in front of lower ones	*Oryctolagus cuniculus* (rabbit)	Schneeke (1941)
Homozygous autosomal recessive	Unknown	Jaws and teeth	Smaller teeth	Retardation of frontal part of mandible, apparent lengthening of upper jaw (overshot)	Upper incisors and canines in front of lower corresponding teeth	*Canis familiaris* (daehshund)	Grüneberg and Lea (1940)
F_2 daehshund × French bulldog	Disharmony of genom	Endocrines, skeleton, others	Many, generalized	Overshot or undershot	Very variable	*Canis familiaris* (cross)	Stockard and Johnson (1941)
Unknown	Unknown	Maxilla	Not conspicuous	Maxillary neck "crowded"	Prominent upper incisors	*Homo sapiens* (man)	Numerous authors in dental literature (also other tooth anomalies)
Different genes, also possibly dominant ones	Unknown	Mandible	Not conspicuous	Undershot			
Unknown	Unknown	Neural or soft tissues	Open lip posture	Undershot			Ballard (1957)

therapeutically, though they may help after surgical or prosthetic treatment. That does not mean that certain habits, such as thumb- or finger-sucking, may not aggravate anomalies of dental position. But they do not by themselves cause those anomalies, as is shown by the fact that only a minority of thumb-suckers show malocclusion and not all malocclueded children suck their thumbs or fingers. On the other hand, innate posture may apparently set a limit to the range inside which normal occlusion can be achieved in spite of a disparity of the jaws. The extent of this range and the acute and genetical factors which control it are, however, to my knowledge unknown and could provide interesting objects for study, and so can the oral habits in general.

I have come to the end of my discourse. The problems of orthodontics are usually studied by what is sometimes called longitudinal approach. If I have persuaded you that there might be some profit in extending your interest even beyond the life-span of your patients and "latitudinally" even to their families, I shall be well contented.

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CONTRASTING TREATMENT IN TWO BROTHERS

By **P. H. BURKE**, B.D.S., H.D.D., D.D.O.

CASE REPORTS

THESE reports give an account of the clinical histories of two brothers who, though possessing apparently similar malocclusions of the Angle's Class II, division 1 type, responded to treatment differently.

John.—

CLINICAL HISTORY.—Of the two brothers John and Roger, John was the elder by four years. He first attended for the treatment of prominent maxillary incisors in 1948, at the age of 7 years 5 months. The family history revealed that the mother had a marked Angle's Class II, division 1 malocclusion with the maxillary incisors excessively proclined over the lower lip. Her

Fig. 1.—John. Facial views at ages 7 yr. 5 mth. and 18 yr. 3 mth.

Given at the meeting held on December 14, 1959,

anterior overbite was complete and excessive. During the swallow there was a marked contraction of the lower lip bencath the upper incisors, and these lips were judged to be potentially competent. Otherwise the family history was negative. General health was essentially average.

On clinical examination John's physique was noted to be small (*Fig.* 5). His facial profile suggested some degree of postnormality and labial incompetence (*Fig.* 1). The lower lip rested beneath the incisal edge of the maxillary incisors and his lips were described as incompetent, though mildly so. A tracing from a lateral skull radiograph showed that he was skeletally postnormal (*Fig.* 4 A). The incisal relationship showed a marked maxillary overjet (11 mm.) and an incomplete anterior overbite. This suggested that although the swallowing mechanism was not examined there was an anterior tongue thrust with probably a compensatory lower lip contraction beneath the maxillary incisors. The arch relationship was typical of an Angle's Class II,

Fig. 2.—John. Study models at ages 7 yr. 5 mth. and 18 yr. 3 mth.

division 1 type of malocclusion: arch form was fairly narrow (*Fig.* 2).

There was no crowding with the exception of mild abio-version of the mandibular left central incisor. The dentition was in the mixed stage. Tooth quality, oral hygiene, and gingival health were satisfactory. In view of the family history the outlook for co-operation was anticipated to be good.

Fig. 3.—Roger. Study models at ages 8 yr. 4 mth. and 14 yr. 3 mth.

TREATMENT.—It was decided to attempt tooth movement in the mixed dentition, using an Andresen appliance. This was inserted at the age of 7 years 9 months. Shortly afterwards the boy fell, fracturing both maxillary central incisors, and orthodontic treatment was suspended for eight months. The broken teeth were protected with sedative dressings under stainless steel caps. When a further Andresen appliance was inserted at the age of 8 years 6 months it was activated, but no progress was made in the following year. This form of therapy was therefore abandoned in favour of a plan involving extraction of the maxillary first premolars and intermaxillary traction, using fixed appliances in the permanent dentition. John enjoyed a rest for about one year while

awaiting the cruption of the remaining permanent canine and prcmolar teeth. At the age of 10 years 3 months, after extraction of the maxillary first premolar teeth, fixed appliances were inserted to carry out intermaxillary traction. There was no reduction in the maxillary overjet after two months and so the upper fixed appliance was replaced by a further fixed appliance designed to apply intramaxillary force to retract the maxillary canines, using palatal springs originally designed by Rix (1938). This appliance had a long palatal arch to help anchorage. Three months later, when the maxillary canines were retractcd, retaining spurs were added to the short palatal arch on the original upper appliance and intermaxillary traction was resumed. After wearing fixed appliances for a total period of nine months the maxillary overjet had been reduced to 4·5 mm.

The fixed appliances were replaced by a Hawley retainer with incisal guide plane. This was worn for eleven months and then discarded. The maxillary overjet subsequently began to increase, and in an effort to control the relapse the boy wore an oral screen for about one year. During this time the overjet increased until it stabilized at about 8 mm., but a part of this increase was due to the additional thickness of two acrylic caps which replaced the stainless steel caps on the central incisors.

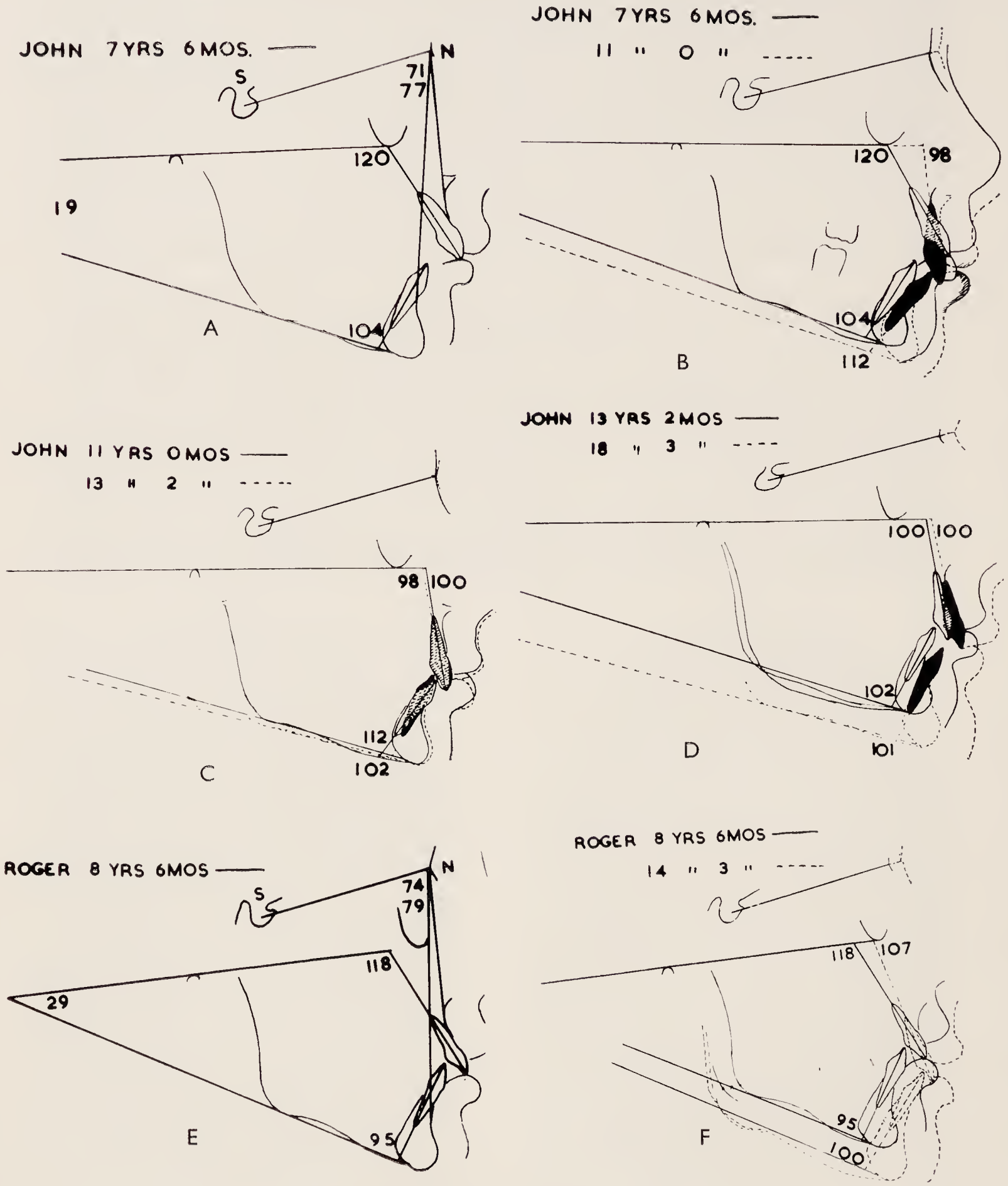

Fig. 4.—Tracings of lateral skull radiographs.

Active appliances were worn for twenty-one months, passive appliances for twenty-three months.

In the following five years of observation the overjet for the upper right central has diminished to 6 mm., mainly due to the replacement of the acrylic cap on this tooth by a porcelain jacket crown. The loss of tooth tissue on the left central incisor was deemed acceptable. The overjet on this tooth decreased to 3·5 mm., but this was related to increased labio-version of the lower left central incisor. The anterior overbite has remained stable. When the buccal occlusion is examined some recession of the gingivæ is noted on the mesio-buccal roots of both maxillary first permanent molars. The first premolar spaces have closed. There is also evidence of mesial tilting of the teeth in the upper buccal segments. The occlusal view of the study models shows the increase in imbrication of the mandibular incisors and in particular the labio-version of the left central incisor (*Fig.* 2). Radiographs taken in connexion with the porcelain jacket crown show no evidence of apical resorption of the maxillary incisors. The lips are now competent. The resting lower lip line is just above the incisal edges of the maxillary incisors (*Fig.* 1). His swallow is normal. The general configuration of the face has altered with growth and development. This boy's adolescent growth-spurt occurred relatively late (at about 15 years of age), but was vigorous. His present age is 18 years 3 months.

Roger.—

Clinical History.—Roger was four years younger than John. He presented, also for treatment of prominent maxillary incisors, at the age of 8 years and 4 months. His general health was good.

On examination he was found to be more advanced in his general growth (*Fig.* 5), and this was reflected in the growth of his jaws. The dental base relationship was postnormal though not so marked as his brother's (*Fig.* 4 E). The resting lower lip line was below the incisal edges of the maxillary incisors, the lips being definitely incompetent. During the swallow there was contraction of the lower lip beneath the maxillary incisors. No anterior tongue thrust was detected.

The incisal relationship was again one of marked maxillary overjet though not so severe as that of his brother, 9 mm. against 11 mm. The anterior overbite was complete and excessive. The arch relationship was typical of an Angle's Class II, division 1 malocclusion (*Fig.* 3). There was no crowding. The dentition was at the same stage as John's when he first presented for treatment. The main difference in arch form was a slightly greater intercanine dimension. Tooth quality, oral hygiene, and gingival health were satisfactory.

Treatment.—To test co-operation, which was suspected to be a possible reason for the failure of John's early treatment, Roger was given a removable bite plane which he wore well for six months, and which reduced the excessive anterior overbite. Co-operation being assured he was then given an Andresen appliance, at the age of 9 years, in an effort to correct the arch relationship. Six months later the biting position was brought forward and fifteen months after the insertion of the appliance the maxillary overjet had been reduced from 9 mm. to 4·5 mm. In a further six months the buccal occlusion had been corrected on the right side and was "cusp-to-cusp" on the left side. A new Andresen appliance was provided at this stage to guide the active eruption of the premolar teeth. Seven months later a final Andresen appliance was provided with a less protruded bite. This appliance carried boxed-in active spurs in 0·7 mm. stainless steel wire, bearing on the mesial aspects of the maxillary first permanent molars to complete their distal movement, particularly on the left side, which was lagging behind the right side. Appliances were completely discarded at the age of 12 years 2 months, the Andresen appliances having been worn three years two months. The occlusion was now normal, with the exception of a mild degree of disto-occlusion on the left side. The overjet was 4·5 mm.

In the subsequent two-year period of observation the occlusion has remained stable (*Fig.* 3). There is no deviation on closing related to the cheek–tooth occlusion on the left side. There is a mild degree of imbrication in the mandibular incisor area.

His lips are still incompetent, but he frequently hides this by voluntary compensatory contraction. At rest, however, the lower lip line is below the incisal edges of the maxillary incisors while the upper lip line is fairly high on the labial surface of the incisors. During the swallow, he achieves a firm lip seal over the incisors by a marked contraction of both upper and lower lips.

Roger's present age is 14 years 3 months.

TREATMENT ANALYSIS

John.—Analysis of John's treatment was carried out by superimposing tracings of lateral skull radiographs on S (sella turciea) and orientation on the SN (sella-nasion) line, i.e., the method used by Brodie (1941) (*Fig.* 4).

Stage 1 : 7 *years* 6 *months*–11*years* (*Fig.* 4 B).–This stage included John's abortive treatment with the Andresen appliance and his intermaxillary traction. The increment of growth was large and the direction of growth of the face was downwards and forwards. Throughout the series the dental base relationship as measured by the angles SNA and SNB remained unchanged. In addition to the growth changes the maxillary incisors were retroclined some 22° and the mandibular incisors were proclined about 8°. The lower lip, with better support from the lower incisors, now made a seal with the upper lip over the labial surface of the upper incisors. This suggests that the lips may have been originally potentially competent.

Stage 2: 11 *years*–13 *years* 2 *months* (*Fig.* 4 C).—This was the stage of retention and partial relapse. The increment of growth was negligible. If one accepts Krogman and Sassouni's (1957) estimate of 3°–4° as the normal error to be expected when measuring tooth inclination, the maxillary incisors have retained their new inclination. The mandibular incisors, however, have relapsed to approximately their original inclination. This explains

the success of the Hawley retainer with the incisal guide plane and the lack of success of the oral screen as retainers. The relapse of the mandibular incisors has reduced support for the lower lip, whose posture has deteriorated slightly.

Stage 3: 13 *years* 2 *months*–18 *years* 3 *months* (*Fig.* 4 D).—This was the stage of observation only. The increment of growth is large since it includes the adolescent growth spurt. The inclination of upper and lower incisors has remained stable. The lip posture remains competent.

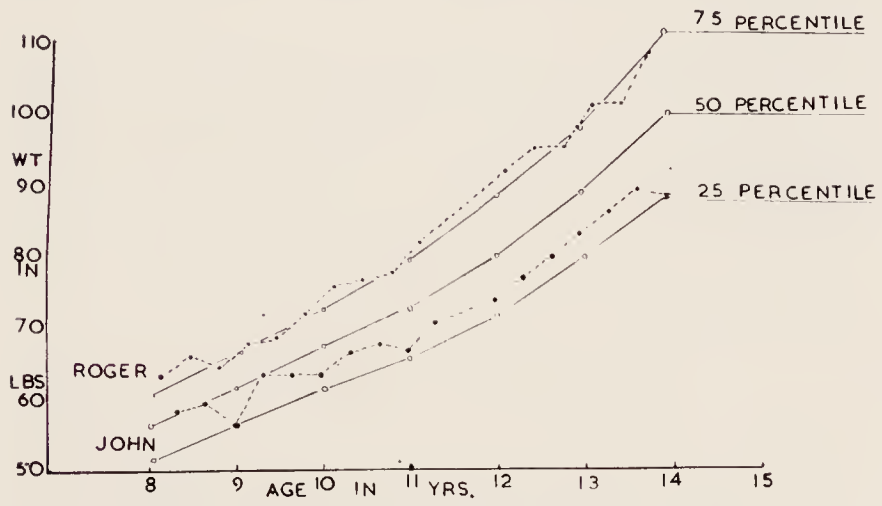

Fig. 5.—Serial growth records in weight.

Roger.—

Stage 1: 8 *years* 6 *months*–14 *years* 3 *months* (*Fig.* 4 E).—This period includes Roger's active treatment and the two-year period of observation. The increment of facial growth was quite naturally large, but the direction of growth was more downwards and less forwards than his brother. The dental base relationship as measured by the angles SNA and SNB remained unaltered. In addition to the growth changes, the maxillary incisors have been retroclined about 11° and the mandibular incisors have been proclined some 5°. The lips are seen to be incompetent at both ages.

If growth of the jaws can be assessed by the anteroposterior dimensions available on lateral skull radiographs it is interesting to note that Roger's jaw growth at 8 years 6 months was equivalent to John's at 11 years, and again that his jaw growth at 14 years 3 months was equivalent to John's at 18 years 3 months.

COMMENT

This case report is not intended to support a plea for the indiscriminate use of Andresen appliances for the treatment of Angle's Class II, division 1 malocclusions in the mixed dentition. I do, however, wish to draw attention to a possible link between growth of the jaws and response to mixed dentitional treatment using the Andresen appliance.

Apart from the evidence of the differences in projected jaw size on the lateral skull radiographs, general growth records showed Roger's growth to be in advance of his brother's. According to Sutcliffe and Canham's (1950) growth tables for English children, Roger's serial weight records rested on or about the 75 percentile level whereas John's records fell consistently in the 25–50 percentile group (*Fig.* 5). The difference in height was less marked, but Roger was always ahead of John at corresponding ages and the difference gradually increased to nearly 2 in. at 14 years of age. Thus Roger lay just about the 75 percentile level for height and John just above the 50 percentile level. Shepherd, Scholl, and Vizoso (1952) have demonstrated the association between stature and jaw size.

It is, of course, only reasonable to expect that orthodontic tooth movement *en masse* will take place more easily when jaw growth is good and the size of the dental bases is greater. Comment has been made upon the absence of crowding as an indication for the use of the Andresen appliance by McCallin (1959). General growth records may be of help to clarify the indications for the use of this appliance.

In my opinion, factors favourable to successful mixed dentitional treatment using the Andresen appliance are:—

1. An Angle's Class II, division 1 arch relationship on a normal or mildly postnormal dental base relationship.
2. Lips which are potentially competent or mildly incompetent.
3. Good jaw growth.
4. Absence of proclined mandibular incisors.
5. Assured patient co-operation.
6. An operator who has been specifically trained in the manipulation of the Andresen appliance.

Acknowledgement.—I wish to thank the Photographic Department of the Newcastle upon Tyne Dental Hospital for its care in producing the illustrations.

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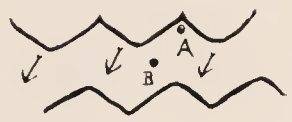
DISCUSSION

The President thanked Mr. Burke for his communication. Two case reports spread over a fair interval of time were something on which they had long wanted a report. Although Mr. Burke had shown a number of slides, two or three times as many could have been shown and it was astonishing how much material one could accumulate when one went into a case in detail. The communication could have been supported by many further intra-oral films and by cephalometric films, but that would have taken them beyond the limits of their time. He now invited discussion.

Mr. Breakspear said that he hesitated to criticize any case which someone else had seen because he knew that his own were very much open to criticism. They all knew how difficult that type of case was. He thought that he would probably have done the same as Mr. Burke. There were many cases in which one could not get a perfect result. The one point he wanted to make was that the insertion of the labial bow into the Andresen appliance seemed to be rather high and to make it difficult to trim the cusps in the most effective way. He could illustrate that with a drawing:



In the case shown, he noticed that the bow was inserted at A and that the wire then obstructed the trimming of the appliance. He instructed his technician always to insert it at B, about half-way between the upper and lower teeth and about one-third of the way back along the buccal surface of the upper first premolar. The appliance could then be trimmed as shown by the arrows.

Mr. Poulter thanked Mr. Burke for presenting two very interesting cases. Had he considered leaving treatment in both cases until very much later when the deciduous dentition had been entirely lost, instead of putting in an Andresen appliance at the mixed dentition stage?

Mr. Burke (to Mr. Poulter) replied that there was a great vogue in favour of treatment in permanent dentition at the moment. Some of the reasons for this were the difficulty of using intermaxillary traction in the mixed dentition and the need to retain the result until the canines had erupted. In his opinion, a very effective way of treating *suitable cases* of the Angle's Class II, division 1 type was the Andresen appliance in the mixed dentition. Otherwise, he agreed that they should wait for permanent dentition. One of the advantages of the Andresen appliance was that in the milder Angle's Class II, division 1 cases one did not need to extract in the upper arch. He had not extracted in the younger boy, although it might have reduced the strain on the mandibular anchorage if, for instance, the maxillary second molars had been extracted.

Mr. Tulley asked Mr. Burke how he trimmed the lower part of the Andresen in the cases shown. Did he keep the acrylic over the lower incisors and trim just occlusal over the lower molar region, to give them freedom to rise occlusally but hold them mesio-distally? He had found that this tended to help anchorage.

Mr. Burke (to Mr. Tulley) replied that if the incisal edges were not covered the incisors were going to erupt, which one did not want; therefore the incisal edges had to be covered to act as a stop. He did not expect to be able to guide the mandibular cheek teeth anteriorly. He cleared them for eruption but more or less vertically.

Miss Clinch thanked Mr. Burke for having shown the cases. She did not know whether it was the slightest help, but she thought that better results were obtained in the second case because Mr. Burke had not extracted. The younger boy had a postnormal occlusion of the mandibular arch and this arch relationship had been corrected, so that Mr. Burke had got very much better results than with the older brother, where the postnormal arch relationship had been ignored. The better results might also have been partly due to the fact that the younger child had a better potential growth pattern.

Mr. Burke (to Miss Clinch) said that he had been interested in the growth background and intended to probe into the growth records of the elder boy in the hope of illustrating that side.

Mr. Walther thanked Mr. Burke for an excellent communication. Was he not right in thinking that the first boy postured forward considerably? He had found that children who postured forward did not react to the Andresen appliance as well as others.

Mr. Burke (to Mr. Walther) replied that in 1948 the downwards and forwards habitual postural position was not known to him and he had not examined for it. If it had been present it would possibly have been a further explanation of the lack of response of the first patient to the Andresen appliance.

Mr. Tulley said that the occlusion in the intra-oral photographs appeared not nearly so abnormal as on the model.

Mr. Burke (to Mr. Tulley) replied that it was said that the camera never lied. The occlusion on the model was a full Class II, with no forward drift of mandibular buccal segments. Intra-orally there was a definite incomplete anterior overbite, and the magnitude of the overjet was 11 mm. That was as far as he could define it.

The President said that several things had happened since the case-history began. Nearly eleven years had

gone by. Eleven years ago they were all eleven years younger, including the children, and so was orthodontic knowledge, which had modified with time. They had had an interesting exercise in retrospection. He hoped that other cases would be chosen which would benefit members in a similar way.

Mr. Wilson said that he had fully trimmed Andresen appliances eleven years ago to control the eruption of the molars. Nowadays, he did so very seldom. Had Mr. Burke had the same experience?

Mr. Burke (to Mr. Wilson) said that indeed he had. He had found that the most valuable time for activation was during the time of active eruption of the premolar teeth. The Andresen appliance for the second boy was not trimmed until the deciduous teeth began to exfoliate. He felt that the action of the unactivated Andresen was due, possibly, to the mandible trying to get back to its rest position and thereby applying muscular force through the appliance to tilt the lower teeth anteriorly and the upper teeth posteriorly, in other words, a form of intermaxillary traction.

Mr. Mills said he felt that we were all apt to regard the question of extractions as one of principle rather than of expediency. In his opinion, the only reason for extracting teeth in any malocclusion was to correct the condition of crowding. He felt, however, that in many cases of Class II, division 1 malocclusion, crowding was in fact an important actiological factor. He thought that in Mr. Burke's two cases the first boy had a potentially crowded mouth. In a case like this, distal movement of the upper cheek teeth was impossible since there was a continuous row of teeth right into the tuberosity. In the second boy, the jaws were longer and the Andresen appliance could move the teeth distally. Did Mr. Burke agree with this?

Mr. Burke agreed with what Mr. Mills had said.

The President said that they had two other communications, but he thought that the discussion had achieved their object, in that they had discussed two cases for which they had records, even though those records went back a long time and were not as complete as they might have wished. He had no doubt that if members looked back over their records for the last ten years, they would find interesting cases which could be discussed in a similar manner, particularly cases where there was some element of doubt or other important points for discussion. If such cases were brought forward, they would all learn the maximum from both their successes and their mistakes. He had great pleasure in thanking Mr. Burke for his communication. (*Applause.*)

FURTHER REPORT ON A CASE DEMONSTRATING BODILY MOVEMENT OF UPPER INCISOR TEETH

By **J. R. HALDEN**, L.D.S. R.C.S., B.D.S., D.Orth. R.C.S.

EARLIER this year Dr. A. Goldstein of Chieago gave a paper at Guy's Hospital in whieh he showed a number of treated eases whieh had relapsed, espeeially in the sense that they had reverted to their former faeial pattern. The inferenee was that it is not worth while to attempt to improve faeial æstheties by advaneed treatment proeedures beeause they are doomed to relapse anyway. Instead of oeeasioning sadness this viewpoint was reeeived with sueh great glee in some aeademie quarters that I wondered whether there was not a little malieious joy on the part of those who are reluetant to believe that these advaneed proeedures ean be sueeessful. Time alone will tell, but meantime I thought you might like to follow up one ease that I reported on in my paper on the edgewise applianee. I will repeat what I said then:—

Fig. 1.—Photographs at commencement of treatment.

"This girl, aged twelve years two months, was an Angle Class I, mild Skeletal II with inereased overbite and slightly inereased overjet assoeiated with slight lip ineompetenee at rest (*Fig.* 1). I think her mandible is a bit depressed from true rest position in the lower pair of photographs. *Fig.* 2 shows the models before treatment. It was felt that shc was perhaps a little too full around the lips, and that her profile might be improved and her lips made competent by retraction of the lower

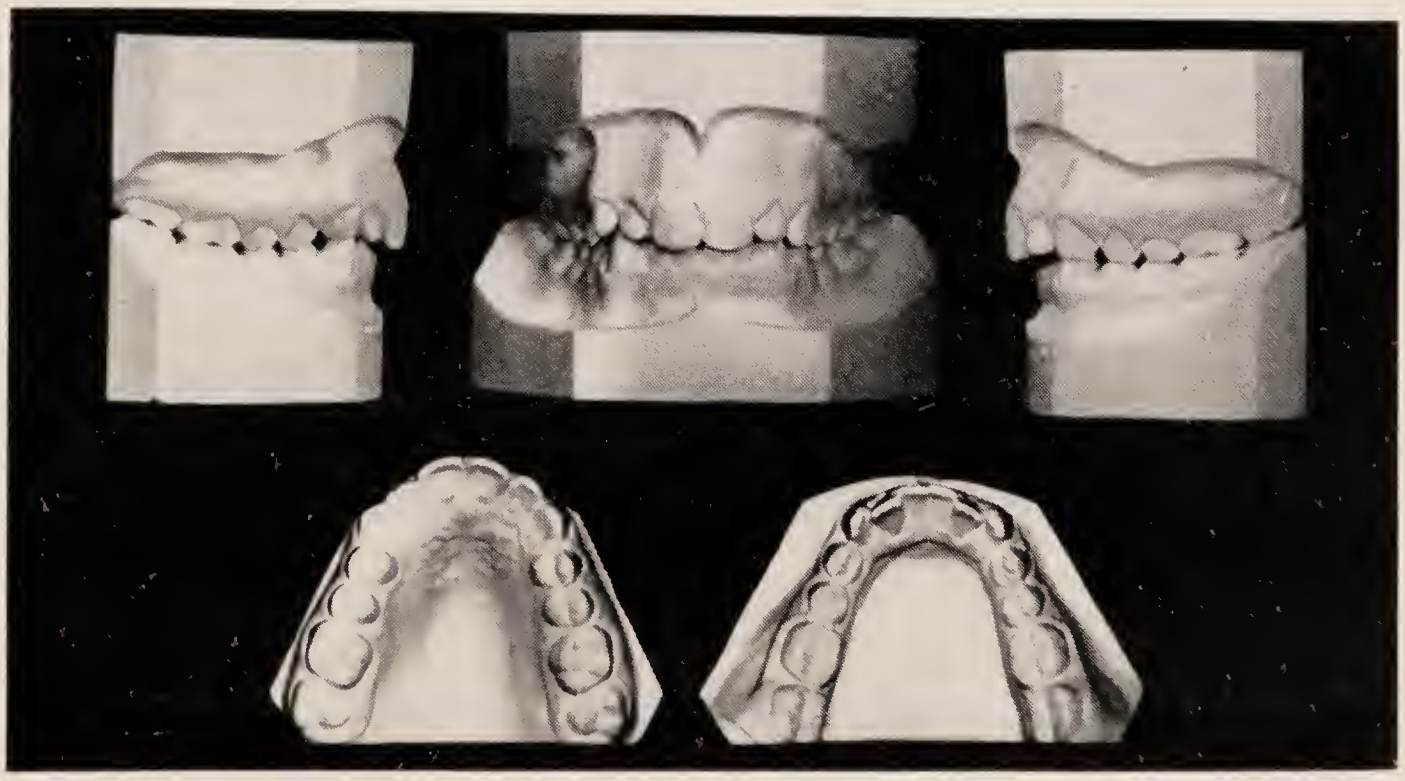


Fig. 2.—Models at commencement of treatment.

Given at the meeting held on December 14, 1959.

labial segment to about the position where it was eventually taken, followed by bodily retraction of the upper labial segment to the lower labial segment. Four first premolars were extracted, and treatment basically as outlined by Tweed carried out. *Fig.* 3 shows the models at retention. The headplates (*Fig.* 4) show that there has been a considerable reduction of dento-alveolar convexity, and that the upper incisor apices are nearer the palatal wall after treatment. The tracings (*Fig.* 5), super-imposed on SN and Sella, show that the upper central incisor crowns were retracted 8 mm. and their apices were retracted 6 mm.,

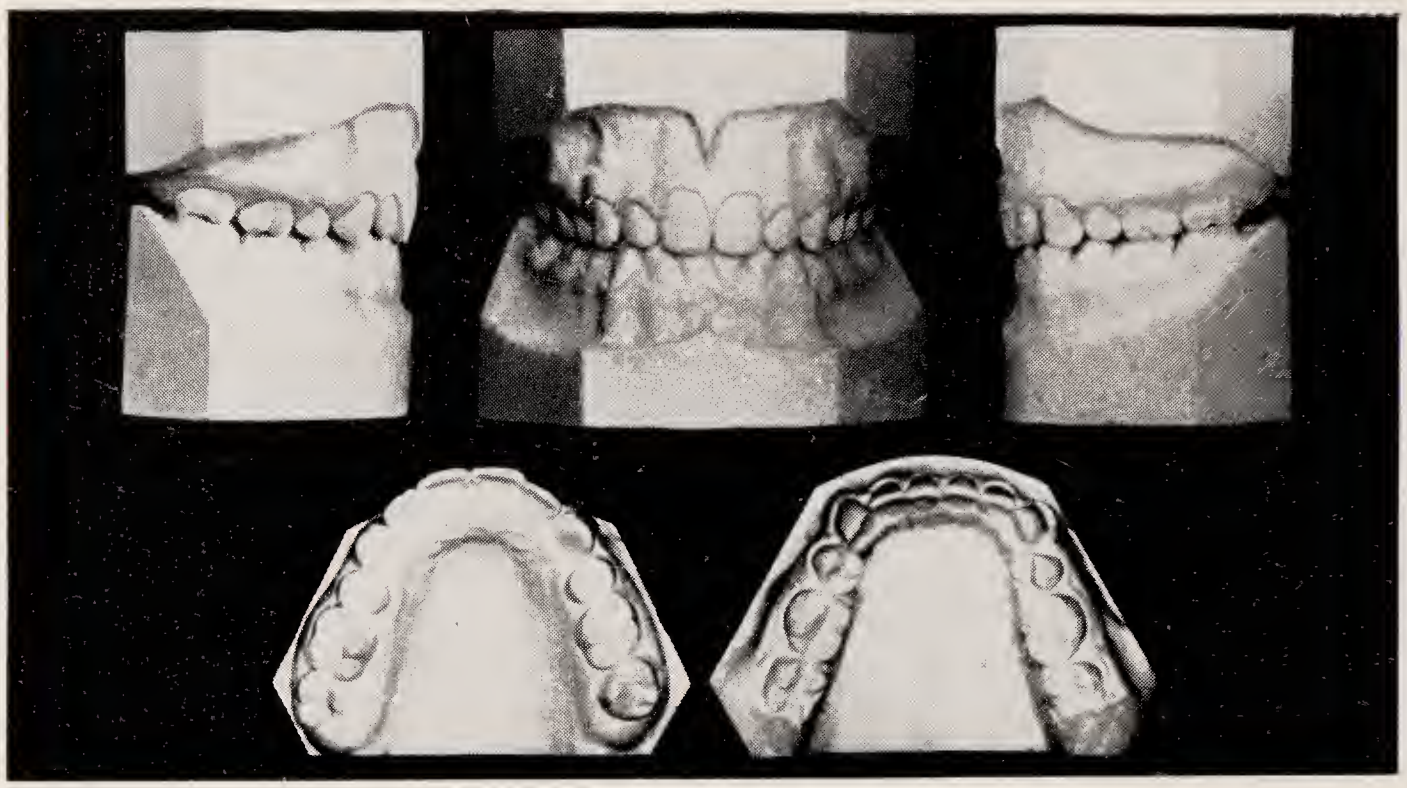
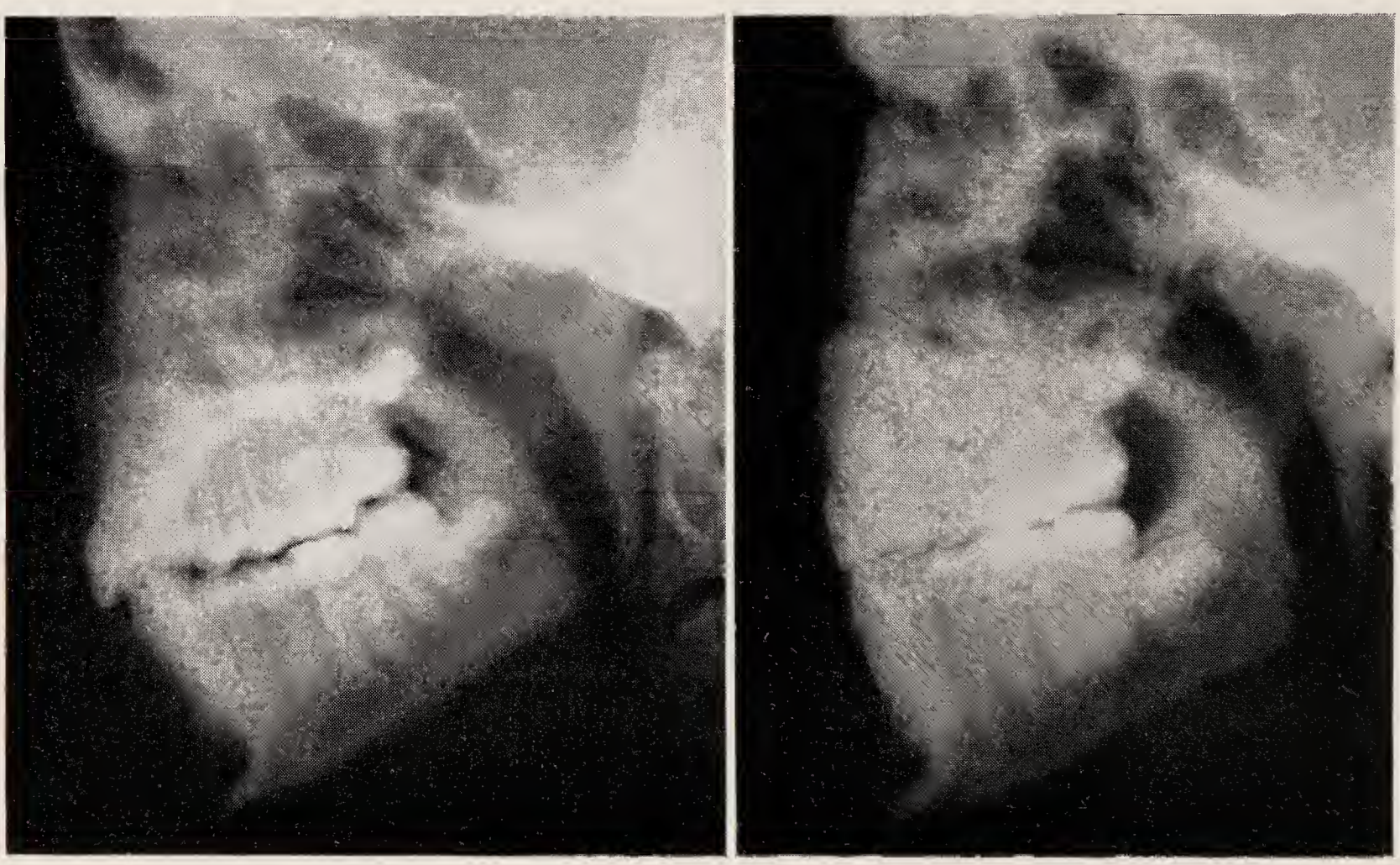


Fig. 3.—Models at retention.



A B

Fig. 4.—Headplates before treatment and at retention. Mandible postured forward a little in A. Note upper incisor apical position relative to A point and palatal wall before and after treatment. The bone anterior to upper incisor apices in B will disappear with a consequent posterior shift of A point.

less a small magnification correction for the conventional 5 feet target distance. The photographs after treatment show that her lips became quite competent, and the profile perhaps a little too flat for some tastes (*Fig.* 6);

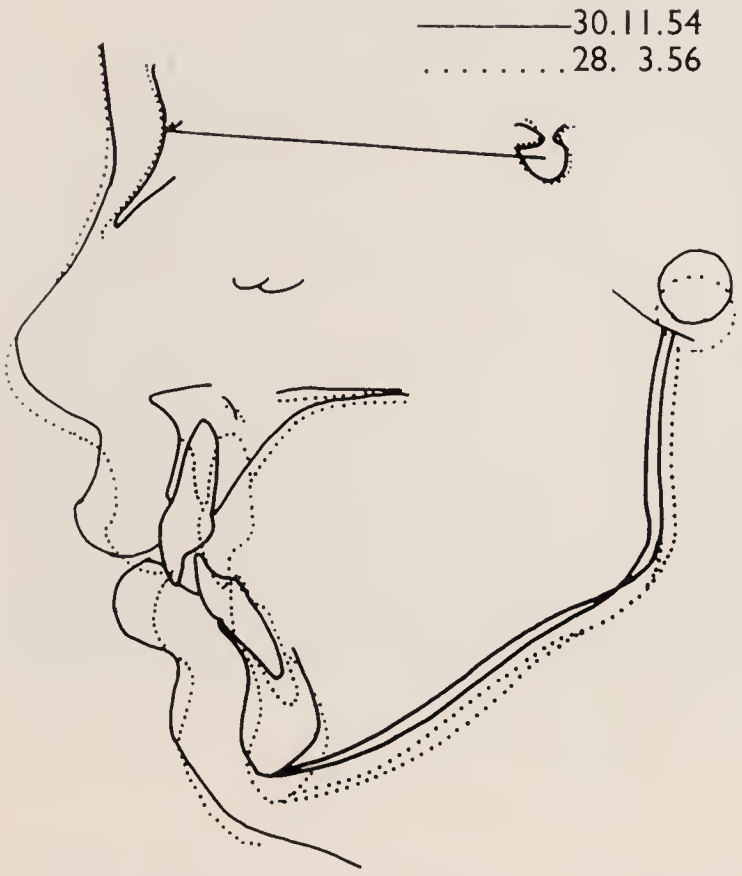


Fig. 5.—Tracings before and after treatment.

however, I am nearly certain that when her occlusion settles down after retaining plates are left out she will show an optimum facial change in her morphology. Treatment time from extractions to retention was fifteen months."

This girl was the first of the eight cases I showed to come out of retention because she broke three upper and three lower retainers and I refused to make any more. She had just over thirteen months' retention instead of the two years I usually require. At that time I thought it was good treatment to allow some expansion of the lower canines during their retraction, provided they were kept within the line of the arch. I was wrong. Nearly all those

Fig. 6.—Photographs at retention. Optimum change is still to occur when occlusion has settled in.

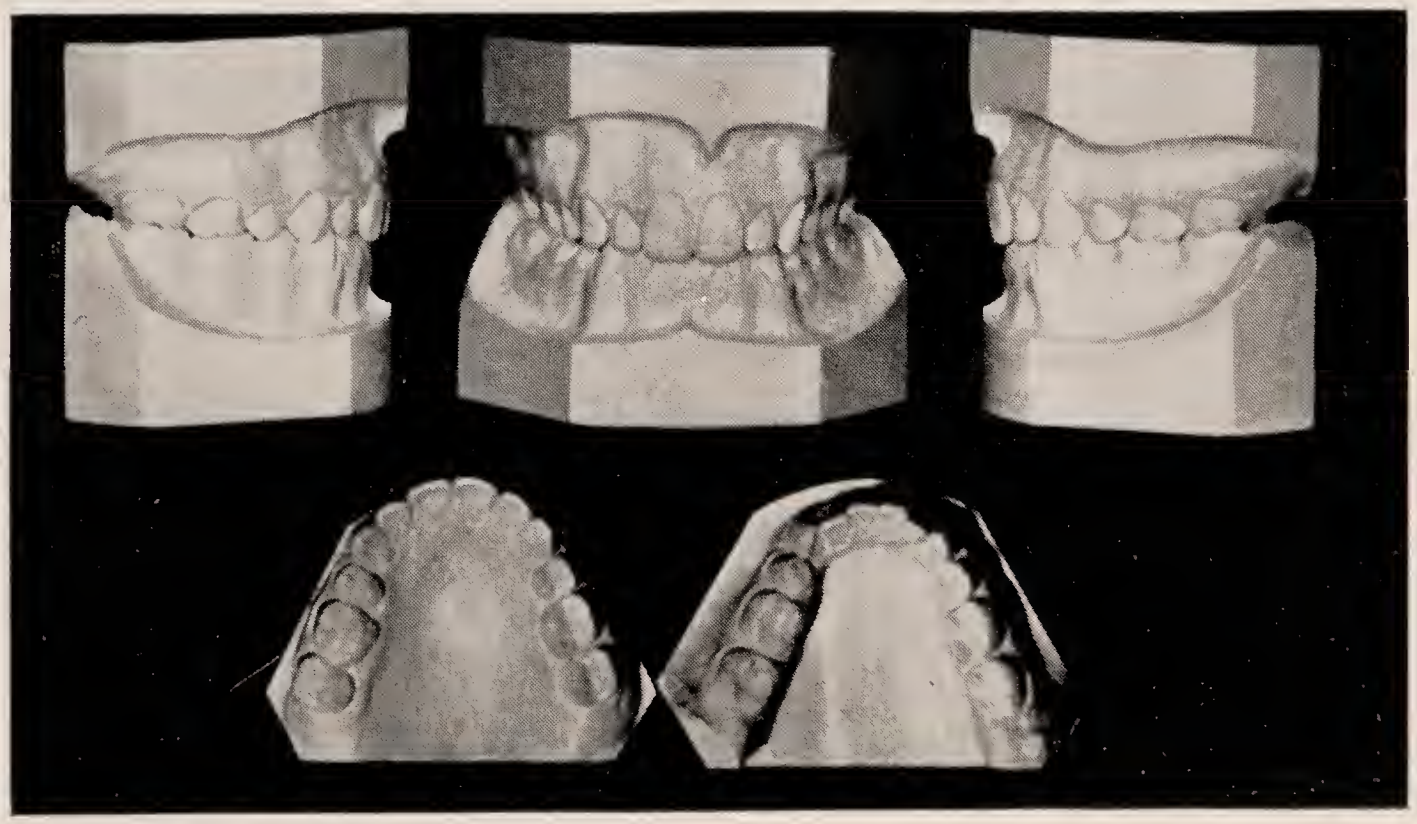


Fig. 7.—Models nineteen months out of retention.

cases have relapsed to the extent that the lower canines have reverted to their former width across the median plane, often to less than their former width.

These models (*Fig.* 7) were made nineteen months after retention was discontinued.

Fig. 8.—Headplate taken seven months out of retention. Note that the bone mesial to the upper incisor apices has disappeared and that the apices are still back relative to the palatal wall.

Fig. 9.—Headplate taken twenty-seven months out of retention. Note no change in incisor position has occurred in twenty months.

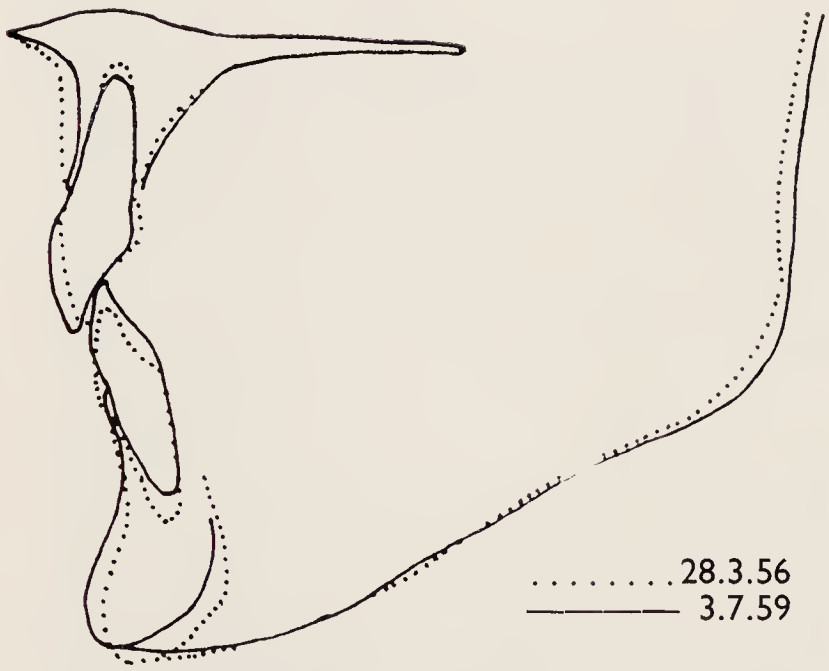


Fig. 10.—Tracing of headplate twenty-seven months out of retention superimposed on tracing of headplate at retention.

Lower canine width is now less than the original width, which isn't fair!

Fig. 8 shows the position seven months only after retention was discontinued. Note that overbite is now normal but that the bone through which the upper incisor apices was moved has disappeared, and A point has been set back several millimetres. (*Compare Figs.* 8 and 4 B.) This bears out exactly what

Fig. 11.—Photographs before treatment and two years out of retention.

Holdaway and others have reported. Note that the upper incisor apices are still right back relative to the palatal wall.

Fig. 9 shows the position twenty months later, or twenty-seven months out of retention.

Note that there is virtually no change at all.

Fig. 10 shows the tracing of the slide just shown superimposed on the tracing of the headplate at retention, using anterior nasal spine as registration point.

Fig. 11 shows the adaptation of the facial contours to the new position of the denture and, despite the dark shadow, the refinement of the profile.

Acknowledgements.—I should like to thank Professor Ballard for permission to show this case, and the Photographic Department of the Eastman Dental Hospital for their preparation of the slides.

DISCUSSION

The President thanked Mr. Halden for his communication and hoped that others would bring forward similar reports so that developments in later life could be discussed.

Mr. Beresford thanked Mr. Halden for his interesting communication and hoped that he would be forgiven for asking an obvious question while the rest of the company marshalled their thoughts. Could Mr. Halden please tell us something about the vitality of these teeth? What was the effect if a light gauge round labial arch wire, or any similar apparatus, was used in an attempt to produce a similar tooth movement?

Mr. Halden replied that he did not know of the existence of any other apparatus which could be used.

CINÉRADIOGRAPHIC STUDIES OF TONGUE BEHAVIOUR

By **W. J. TULLEY**, B.D.S., F.D.S. R.C.S., D.Orth. R.C.S.
Guy's Hospital Dental School

The advent of the electronic method of image intensification has enabled the radiologist to carry out prolonged screening of patients, and thus to observe movements of the soft tissues of the alimentary tract with the help of radio-opaque media. The X-ray dosage received by the patient is infinitesimal during such screening, and the quality of the picture is excellent.

This technique has, in recent years, been used to take ciné films of movements of the soft tissues in feeding and swallowing (Ardran and Kemp, 1952, 1955). More recently they have investigated the movements of the soft tissues in the suckling cycle (Ardran and Kemp, 1958).

This method of cinéfluorography has been used in the United States to study movements of the mandible and movements of the soft palate in cleft-palate patients (Cooper, 1956).

Grossman has shown films taken in this way to illustrate movements of the tongue and lips in Class II, division 2 malocclusions, and Leighton (1960) showed the use of this apparatus to study swallowing behaviour in infants.

This form of investigation is very relevant to our field of interest, but the technique is particularly difficult. In the lateral view, the teeth, because of their density, tend to mask the movements of the anterior part of the tongue so that the exposure of the film is a very critical matter (*Fig.* 1). Grossman tried to overcome this by placing a metal object on the tip of the lower incisor.

There is a danger of excessive X-ray dosage even with the image intensifier. In taking films with this type of apparatus the output of X-rays has to be increased considerably beyond that required for merely screening. This means that only a few seconds of film can be run and trial shots to perfect exposure cannot be made on the same patient. It is necessary to use another subject in the right age-group with similar facial characteristics, e.g., size of jaws and same density of soft tissues, to obtain a trial exposure.

Despite the present concern with the hazards of radiation, I have been assured that the few seconds of such filming are perfectly harmless, but there would be a danger in

Given at the meeting held on December 14, 1959.

making a serial study in children, as one would like to do.

At present this type of investigation cannot be carried out on a large scale to study the possible changes in tongue activity in the growing child. However, electronic equipment is being developed where films can be taken of television screens and the X-ray dosage is very small indeed.

Another problem is one of head fixation. It is extremely difficult to get a true lateral view of the younger child, and some form of cephalostat attached to the apparatus is desirable.

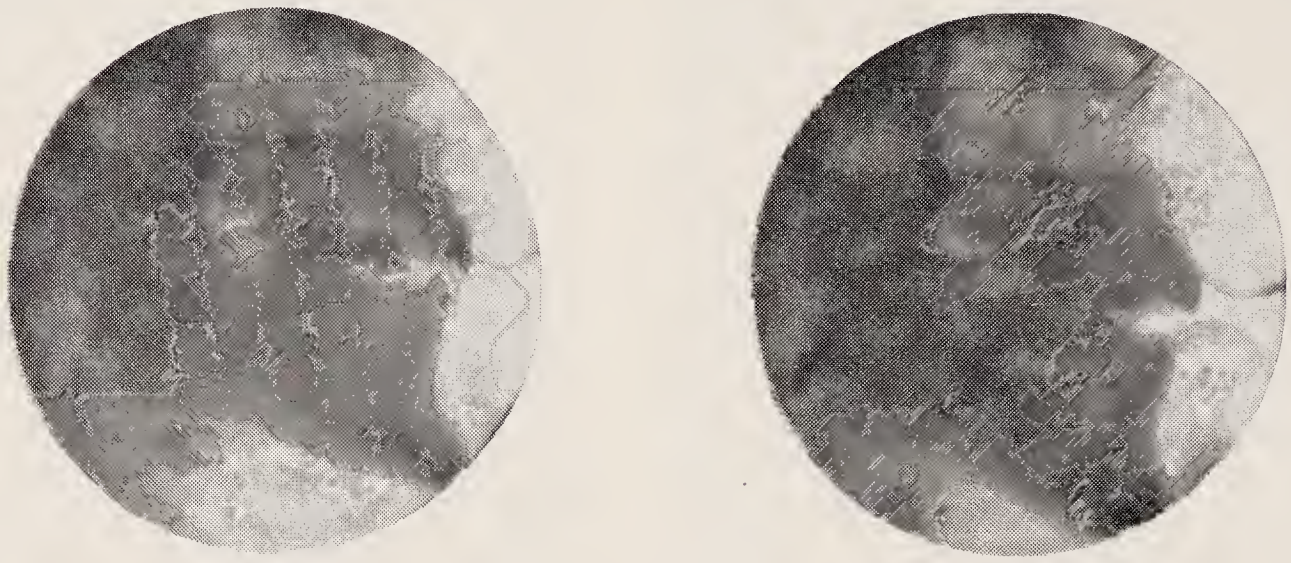
The film to be shown illustrates one example of what would appear to be the normal behaviour of the tongue and lips in swallowing and in speech. This is contrasted with a patient with a marked Skeletal 2 abnormality, Class II, division 1 malocclusion, a marked tongue thrust, and lisping speech. This type of tongue behaviour, taken in association with the skeletal abnormality, makes improvement of incisor position virtually impossible. This type of atypical behaviour was chosen because:—

1. The patient never made tooth contact at any time during swallowing.

2. The open bite and overjet enables the tip of the tongue to be more visible.

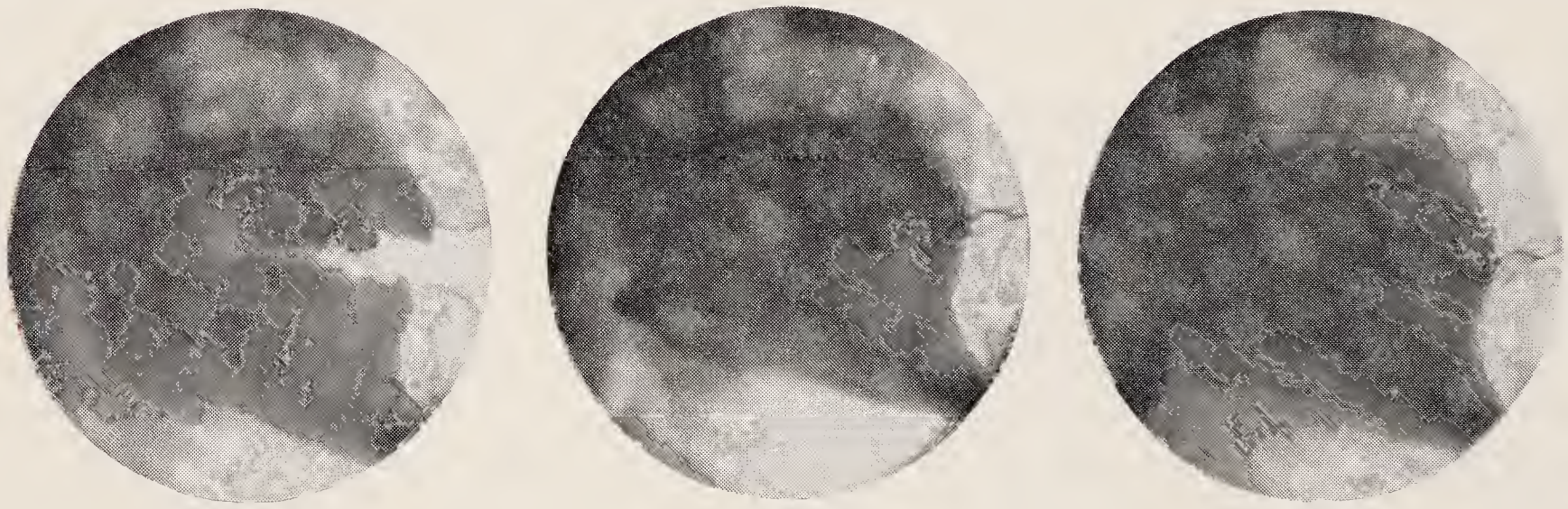
3. It is the type of innate tongue-behaviour which interests us most. (Rix, 1953; Gwynne-Evans, 1954; and Ballard, 1957.)

There are many imperfections in the film, and it is being shown at this stage for helpful



A B

Fig. 1.—Extracted frames from ciné film showing the difficulties in exposure. A, Resting position of tongue. Outline of tongue and soft palate relatively clear. B, Tongue position in "s" sound. Tongue tip can be seen palatal to upper incisors. The full outline of the tongue is obscured by the density of the teeth and the barium which has leaked onto the side of the tongue.



A B C

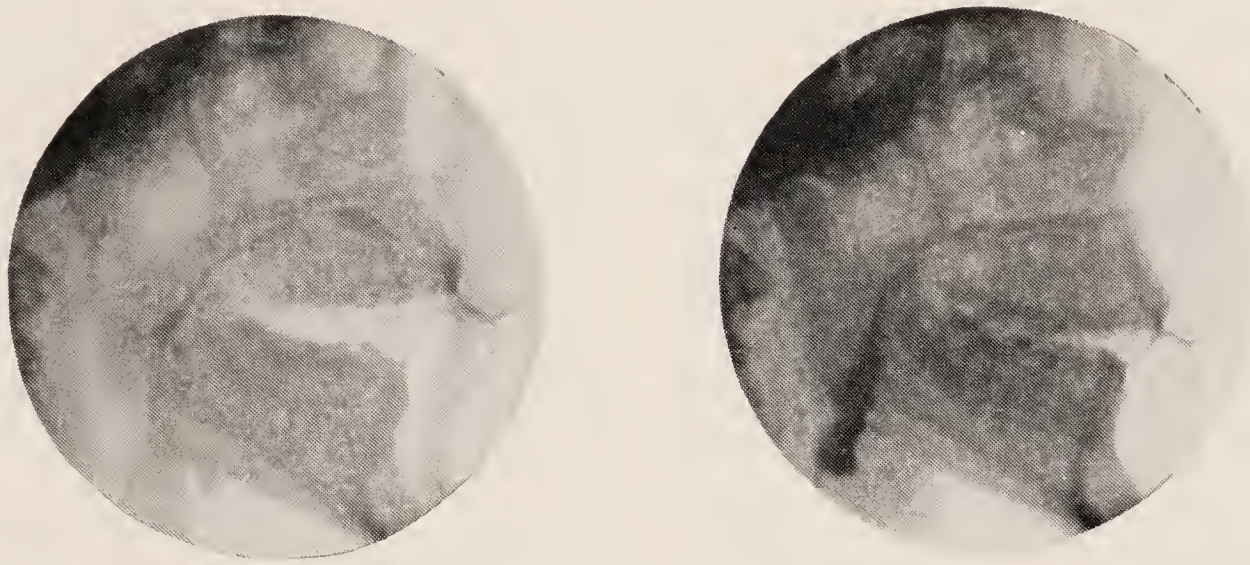
Fig. 2.—"Normal" swallowing sequence (patient with "normal" occlusion). A, Prior to swallowing with barium on dorsum of tongue. B, Teeth together at "mylohyoid phase". Tongue filling oral cavity. Barium spilling into mesopharynx-nasopharyngeal closure. C, Continuation of the last phase.

and constructive criticism. Apart from problems of correct exposure, different densities of barium paste were used to try to improve the soft tissue outline. The best results were obtained by mixing mucilage with the paste so that in certain parts of the film the soft tissues show poor definition whereas in others their outline is extremely clear. (Compare *Fig.* 1 A with *Fig.* 1 B.)

observing movements more closely. An animated viewer is the best way of making a detailed analysis of the movements, and this can be enhanced by tracings of individual frames.

The film was then shown with the following commentary:—

The first subject in this film is swallowing a small quantity of barium paste, performing



A B

Fig. 3.—"Abnormal" swallowing sequence (patient with Class II, division 1 malocclusion). A, Prior to swallowing with barium on dorsum of tongue. B, Mylohyoid phase of swallowing as barium is transferred into the mesopharynx. Note that the teeth are not together and the tongue protrudes between the upper and lower incisors in contact with the contracting lower lip.

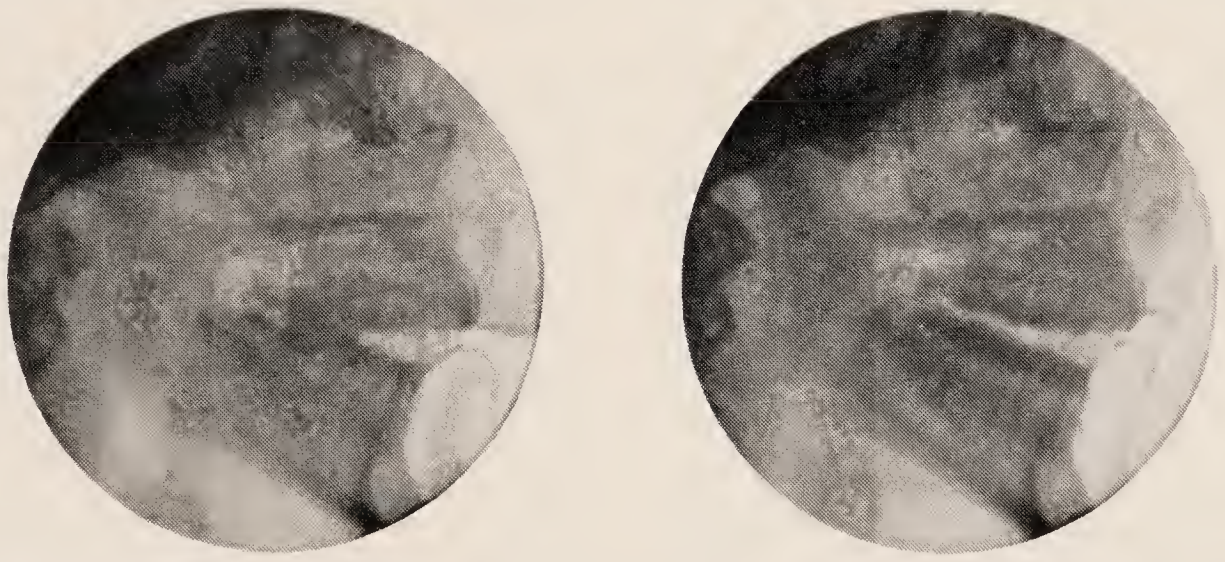


Fig. 4.—Interdental placing of tongue in "s" sounds. The tongue protrudes between the incisors to contact the lower lip.

The film was taken for me in the Department of Radiology, Guy's Hospital, using the Phillips Image Intensification apparatus. It was first filmed on 35-mm. film, from which extracted frames have been taken for prints and then reduced to 16 mm. for projection.

In order to increase the viewing time, the short series of film containing a few swallowing actions can be repeated several times for projection so that one has a chance of what Rix (1946) has described as the basic swallow. You will note the way in which the liquid "bolus" is transferred to the back of the mouth by the tongue, as described by Whillis (1946), and at the mylohyoid phase of swallowing the teeth are placed together and the tongue, contained within the dental arches, bulges back so that the liquid is squirted into the mesopharynx. Nasopharyngeal closure and laryngeal protection is carried out in the

way so clearly described by Ardran and Kemp (*Fig.* 2).

As an example of speech the first subject says "sing a song of sixpence". In the "s" sounds the tip of the tongue is placed just behind the upper incisors and not between them (*Fig.* 1). The movements of the soft palate are clearly seen, and also the fact that the mandible is acting mainly by hinge mechanism during speech.

The second subject, Class II, division 1 with a Skeletal 2 dental base relationship, never occludes her teeth during any stage of swallowing. She has a gulping swallow as described by Rix and the tongue protrudes between the incisor teeth to make contact with the strongly contracting lower lip (*Fig.* 3). In speech she is saying "sing a song of sixpence", when the tip of the tongue is placed between the upper and lower incisors again in contact with the lower lip. Her mandible is protruded to compensate for the discrepancy in dental and jaw relationship, and at rest the tongue shows a forward position between the incisors (*Fig.* 4).

It was not the original intention to use this film for teaching purposes. It was to be merely an investigation of the possibilities of using this technique. It does, however, show graphically the atypical function of the soft tissues, and it was shown for a critical discussion on the technique.

Acknowledgements.—I would like to thank Dr. Dow and Mr. Stammers of the Department of Diagnostic Radiology, Guy's Hospital, for their co-operation and assistance in the preparation of this film, and Mr. Jones of the Dental Photographic Department for the preparation of the film for projection. I would especially like to thank Mr. Rix for his encouragement in this project.

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DISCUSSION

The President said that he thought they should thank not only Mr. Tulley but also the noble patients who participated in a remarkable and interesting set of films.

Opening the discussion, *Mr. Wilson* said that the standard of the presentation had been what they expected of Mr. Tulley, that is, very good.

In the second patient, there seemed to be a number of minor swallows where the tongue and soft palate did not make contact. Could Mr. Tulley explain this ? How was it proposed to treat the case?

Mr. Tulley replied that the movements of soft palate referred to had occurred when the patient was gagging. (*Laughter.*) It was a case which had received considerable orthodontic treatment and which had been referred for a second opinion. The film showed something of the soft tissues, but when the patient, a girl of 15, was examined clinically, her appearance did not seem to be too bad. Her mandible adopted a forward and downward postural position at rest and some conscious lip seal. It was felt that it was better to leave her alone.

Mr. Broadway congratulated Mr. Tulley and the Radiographic Department of Guy's Hospital on an excellent film. Did Mr. Tulley consider that the environment of the X-ray Department and the image intensifier and all the other apparatus had any influence on the swallowing mechanism?

Mr. Tulley said that Mr. Broadway had better ask one of the subjects of the film who was present at the meeting. He did not think that they were greatly influenced. The girl had produced the same sort of picture on clinical examination. He agreed that this method had very severe limitations in research work on that score and on the score of dosage. That was a pity because the method lent itself to serial examination.

Mr. Timms asked whether Mr. Tulley had any figures for dosage since they had found that 10–20 seconds of exposure was a radiation equivalent of less than one-half of one cephalometric headplate.

Mr. Tulley said that that was approximately what he had been told, but one was apt to get over-enthusiastic with the filming.

Mr. Timms said they had not been worried about that dosage. University College Hospital were now using a mixture of glycerin and tantalum powder instead of barium. It was very much easier to use and he thought that the patients liked it. The mixture gave no trouble and could be applied with a small paint brush.

Mr. Nicol said that Mr. Tulley might like to try using a mixture of malted milk with barium sulphide. That made a sticky mess and seemed to stick rather well.

Mr. Tulley said that he was sure that his subjects would be delighted to hear that.

The President asked if anyone else wished to put forward their personal recipe.

He said that he had found it a most interesting evening. They owed much to the hard work which the contributors had devoted to their papers, both in their preparation and presentation. He had to thank Mr. Tulley for his communication and he asked those present to show their appreciation in the usual way. (*Applause.*)

REPORTS OF MEETINGS

ORDINARY MEETING, January 12

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, January 12, 1959, at 7.30 p.m. The President, Professor G. E. M. Hallett, occupied the Chair.

The President said that it was his sad duty first of all to report the death of a former member, Mr. R. G. Daplyn. The meeting stood for a moment.

The Minutes of the Annual General Meeting held on Monday, December 8, 1958, were read by the Secretary, confirmed, and signed by the President as a correct record.

Mr. J. T. Cook, whose election had been confirmed at a previous meeting, was introduced to the President and signed the attendance book.

The following candidates for election were admitted *en bloc* by show of hands:—

Mr. J. D. W. Barnett, B.D.S., 77, Tierney Road, London, S.W.2;

Mr. G. H. Chamberlain, B.D.S., 434, Harborough Road, Leicester;

Mr. G. D. Everard, L.D.S., 14, Chesterfield Road, St. Andrew's, Bristol 6;

Mr. J. L. Hutton, B.D.S., 2, Springfield Road, Kings Heath, Birmingham 14;

Mr. A. S. Lewis, B.D.S., 187, Cathedral Road, Cardiff;

Mr. L. H. Russell, F.D.S. R.C.S., 12G, Observatory Gardens, Kensington, London, W.8;

Mr. Olav Engh, Hammerstadgt, 21b, Oslo, Norway (Corresponding Member).

The President said that if there were any visitors present he hoped they would consider themselves members of the Society for the evening. He would not invite them to take part in the discussion, as there would be none.

He then presented his Presidential Address: "*Inherent Errors in Cephalometric Films and their Reduction*"

ORDINARY MEETING, February 9

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, February 9, 1959, at 7.30 p.m. The President, Professor G. E. M. Hallett, occupied the Chair.

The Minutes of the Ordinary Meeting held on Monday, January 12, 1959, were read by the Secretary, confirmed, and signed by the President as a correct record.

Mr. L. H. Russell, Mr. J. D. W. Barnett, and Mr. R. Marx, whose election had been confirmed at a previous meeting, were introduced to the President and signed the attendance book.

The President said that his next announcement was one which he was very proud to be able to make. The Council had resolved to put forward the name of Professor S. Friel, a very old member of the Society, whose name was known to everybody and upon whose past work he need not dilate any further, as an Honorary Member of the Society. The motion was put to the meeting and Professor S. Friel, of 3, Fitzwilliam Place, Dublin, was elected as Honorary Member.

The following candidates for election were admitted *en bloc* by show of hands:—

Miss A. M. Blandford, L.D.S., 1, High Street, Dinton, Bucks.;

Mr. K. Howse, F.D.S. R.C.S., c/o Messrs. Glyn Mills & Co., Holt's Branch, Kirkland House, Whitehall, S.W.1;

Mr. N. B. McKane, B.D.S., 57, Friar Gate, Derby;

Mr. J. Nelson, B.D.S., 10, Lansdown Place, Clifton, Bristol 8;

Mr. J. D. Rumble, L.D.S., 19, East Cliff, Dover.

The President welcomed any visitors who might be present. He invited them to regard themselves as members for the evening and to take part in the discussion after the paper.

It was a pleasure, he said, to welcome Mr. Toller who would give a paper on "*The Capsule of the Temporomandibular Joint*". Mr. Toller was a man of many parts. His interests ranged, as he was informed by many who knew him better than he did, over a wide field. Various people had mentioned photography, painting, dog breeding, and model

engineering. If this was wrong, Mr. Toller could take it up afterwards, but he had obviously a wide range of interests. It would be remembered that some years previously he had done some interesting work on cysts, and he had been particularly interested in temporomandibular joint arthrography for a long time. A great deal would undoubtedly be learnt from his paper. Orthodontists were always preoccupied with the temporomandibular joint and his paper was eagerly awaited.

Mr. P. A. TOLLER then gave his paper on:—

"*The Capsule of the Temporomandibular Joint*"

[This paper was unfortunately not received for printing.]

ORDINARY MEETING, March 9

AN ORDINARY MEETING of the Society was held at Manson House, 26 Portland Place, London, W.1, on Monday, March 9, 1959, at 7.30 p.m.

The President, Professor G. E. M. Hallett, occupied the Chair.

The Minutes of the Ordinary Meeting of the Society held on Monday, February 9, 1959, were read by the Secretary, confirmed, and signed as a correct record.

Members whose election had been confirmed at a previous meeting were introduced to the Chairman and signed the attendance book.

The following candidates for election were admitted *en bloc* by show of hands:—

Mr. S. D. Finn, 213, Howth Road, Killester, Dublin;

Mr. W. Marsh, F.D.S. R.C.S., c/o Orthodontic Department, Birmingham Dental Hospital, Barwick Street, Birmingham.

The CHAIRMAN welcomed any visitors who might be present, and asked that they should consider themselves members of the Society for the evening. He particularly welcomed Dr. Gresham, from New Zealand.

The paper to be read to the meeting was entitled "*The Relationship between Speech, Tongue Behaviour, and Occlusal Abnormalities*". Its author, Mr. Blyth, had done much research on the subject, which was certainly a valuable and instructive one. It was also timely, because at Copenhagen there had been no less than three papers touching upon various aspects of it.

COUNTRY MEETING, April 17–18

PROFESSOR H. G. RADDEN, Dean of Turner Dental School, said that it gave him very great pleasure to welcome the Society to Manchester. It was to be hoped sincerely that their meeting would be as successful as the meeting of the International Association for Dental Research which was held the previous week, and that it would prove to be as interesting and stimulating.

The PRESIDENT thanked Professor Radden for his welcome. The Society were grateful to the Turner Dental School for the hospitality being afforded them, and to the town of Manchester and the University authorities.

The SECRETARY (Mr. B. C. Leighton) read the Minutes of the meeting held at Manson House on March 9, and they were confirmed and signed as a correct record.

The PRESIDENT then welcomed the guests and invited them to take part in the discussions.

Mr. M. L. Brenchley, B.D.S.; Mr. P. J. M. Priestley, B.D.S.; Mr. P. N. Horswill, L.D.S. R.C.S.; Mr. I. A. Jadwat, L.D.S.; Mr. A. J. C. McIntosh, L.D.S. R.C.S.; and Mrs. V. K. Stanley, L.D.S., candidates for election, were admitted *en bloc* by a show of hands.

The PRESIDENT said he would be pleased to receive written questions for submission to the Brains Trust the following morning.

Papers and demonstrations were given, according to the following programme:—

Programme

Friday, April 17.

9.45 a.m. Short Paper: Mr. D. Munns: "*Impacted Second Mandibular Molars*".

10.15 a.m. Short Paper: Mr. R. T. Broadway: "*Treatment of a Case of Angle Class II, division* 1 *Malocclusion complicated by Gross Overcrowding*".

10.45 a.m. Coffee (Dental School Library).

11.15 a.m. Paper: Mr. J. R. E. Mills: "*Uses and Modifications of the Johnson Twin Wire Arch*".

12.45 p.m. Sherry at the invitation of the Vice-Chancellor, University of Manchester, followed by Luncheon (University Refectory).

2.15 p.m. Paper: Mr. D. F. Glass: "*Rehabilitation of the Child with Cleft Lip and Palate*".

3.30 p.m. Tea (Dental School Library).

4 p.m. Film: Mr. J. H. Gardiner: "*Congenital Partial Aglossia*".

4.30 p.m. Short Paper: Mr. C. D. Parker: "*A Class III Case with Over-closure*".

5 p.m. Short Paper: Mr. D. G. Gould: "*A Class III Case treated with Simple Apparatus*".

7.30 p.m. for 8 p.m. Formal Dinner (Café Royal).

Saturday, April 18.

9.45 a.m. Paper: Mr. J. C. Ritchie: "*The Orthodontic Treatment of a Set of Uniovular Quadruplets*".

10.30 a.m. Coffee (Dental School Library).

11 a.m. Brains Trust.

12 noon. Luncheon (University Refectory).

1.30 p.m. Table Demonstrations: Professor G. E. M. Hallett: "*A New Type of Viewer and Pantographic Reduction for Lateral Skull Radiography*". Mr. J. Angelman: "*The Lateral Arm in Removable Appliance Therapy*". Mr. P. M. Benzies: "*Teaching Models*". Mr. D. A. Dixon: "*An Investigation into the Influence of the Soft Tissues on Tooth Position*". Mr. D. G. Gould: "*A Modified 0·7-mm. Lingual Arch for Anteroposterior Expansion of the Mandibular Arch*". Mr. D. T. Hartley: "*An Orthodontic Clinical Workbench*". Mrs. S. R. Jackson: "*Aids to Appliance Technique*". Mr. J. H. Martin: "*A Modified Electrolyte for Polishing Stainless Steel*"; "*A Modified Jackson Spring*".

3 p.m. Tea (Dental School Library).

ORDINARY MEETING, October 12

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, October 12, 1959, at 7.30 p.m. The President was in the Chair.

The Minutes of the previous Ordinary Meeting were read by the Secretary, confirmed, and signed as a correct record.

The Secretary said that members of the Society had been invited by the British Society of Dental Radiology to hear a paper by Professor Ballard at the Eastman Dental School on Thursday, October 15, at 4.30 p.m. The paper was entitled "*The Role of Dental Radiology in Orthodontics*".

The President welcomed visitors to the meeting and invited them to take part in the discussion and to regard themselves as members for the evening.

He said that the main item of the evening had a domestic flavour, for a paper would be given by the Secretary, Mr. B. C. Leighton, on "*The Early Development of the Deciduous Dentition*". Mr. Leighton was senior lecturer in charge of the Department of Orthodontics at King's College Hospital Dental School. He had done some interesting work in the past, they remembered the work he had done with Professor Humphreys, and they knew him as co-author of a well-known book on orthodontics. He would report during the evening on some fresh work which he was undertaking.

Mr. B. C. Leighton then gave his paper on:

"*The Early Development of the Deciduous Dentition*"

ORDINARY MEETING, November 9

An Ordinary Meeting of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, November 9, 1959, at 7.30 p.m.

The President, Professor G. E. M. Hallett, occupied the Chair.

The Minutes of the Ordinary Meeting held on Monday, October 12, 1959, were read by the Secretary, confirmed, and signed by the President as a correct record.

The following candidates for election were admitted *en bloc* by show of hands:—

Mr. P. E. Bradley, L.D.S. R.C.S., Cedar Hill, Littlebourne, Canterbury, Kent;

Mr. H. L. Parry, L.D.S. R.C.S., 36, Uplands Crescent, Uplands Square, Swansea;

Mr. K. S. Vaus, L.D.S. R.C.S., The Surgery, High Street, Godstone, Surrey;

Mr. T. J. Hackie, 1636, Pandosy Street, Kelowna, B.C., Canada (Corresponding Member);

Mr. S. A. Mortensen, Folktandvarden, Kristianstad, Sweden (Corresponding Member).

The PRESIDENT said the main business of the evening was the thirteenth Northcroft Memorial Lecture, commemorating their founder and benefactor. They had always regarded this as a most important occasion and he was sure that they were to hear a lecture on which they would look back, and which in years to come they would read in the Transactions, as one of the highlights in a series which went back quite a long time.

Their speaker, Dr. H. Kalmus, was Reader in Genetics at University College. He had trained first at Prague University, and had come to Britain in 1939. He had worked with Dr. Penrose, who was well known in the field of genetics and whom he himself, and his colleagues, were hoping to hear very soon in a course of public lectures they were to have.

In recent years Dr. Kalmus had been Associate Professor of Genetics at McGill University and visiting Lecturer at Indiana and Jerusalem Universities, and in 1954 had been the first recipient of the Dreyfus Prize for genetics. He had made many contributions to scientific literature. Many members would remember and would have on their bookshelves—though perhaps a little soiled by now—his well-balanced early contribution, his *Penguin* publication on genetics.

Dr. Kalmus had since published a most readable book, *Variation and Heredity*, and it was with the greatest possible pleasure that he now called upon him to give the Northcroft Memorial Lecture on "*Genetics and Clinical Research*".

Dr. KALMUS then delivered his paper.

The PRESIDENT, in thanking Dr. Kalmus for his lecture, said orthodontists had become more and more preoccupied, particularly of late years, with the imponderables and inexorable relationships between genetics and their own field. Often they wandered rather inexpertly into the field of genetics and sometimes got lost in the jungle of the terminology, the expertise; and it was important that from time to time an expert should bring them back and give them a sense of perspective in viewing this subject which had so important a bearing on their own subject.

It was particularly happy that Dr. Kalmus should have dealt with this in his lecture, the Northcroft Memorial Lecture, and have discussed normality; because Northcroft himself, when writing the Dental Board Lectures years ago, had given certain definitions of normality which would be well remembered by all.

Paraphrasing the Bard he must say what was obvious: "The fault, Dr. Kalmus, lies not in our stars but in our genes"—that was, if they were undershot.

Professor C. F. BALLARD, proposing a vote of thanks to Dr. Kalmus for his Lecture, said a previous Northcroft Memorial Lecturer, Dr. Tanner, in an essay published in *The Lancet* last year, had made a plea that the curriculum for medicine should be on the basis that doctors were human biologists. If that were true of medicine it was true, also, of dentistry. Dentists had to be applied human biologists in their own, more limited, field.

He believed orthodontists were the first in the dental field to accept that view, as had been demonstrated by their choice of Dr. Kalmus on that occasion, and those whom they had previously invited as Northcroft Memorial Lecturers.

The work that was being done by Dr. Kalmus was highly important to the human biologist and he had demonstrated, in his lecture, how important it was in dentistry, also. When more enlightened views prevailed in the undergraduate dental schools, undergraduates would not commence their career, as they did now, within a narrow field, but would be stimulated by people like Dr. Kalmus and others to take a broader view.

He felt they could congratuate themselves on their choice of Dr. Kalmus for the lecture. As he had pointed out, it was fitting to have a biologist and geneticist, for it was now many years since they had had Doctor (now Professor) Groneberg.

It was his pleasure, on behalf of the British Society for the Study of Orthodontics, to thank Dr. Kalmus for his lecture and to propose a hearty vote of thanks.

The PRESIDENT, joining his thanks with Professor Ballard's for the most interesting

lecture delivered by Professor Kalmus, apologized for having failed, earlier, to extend a warm welcome to all those present.

He announced that the next Meeting would be held on Monday, December 14, 1959, when there would be three speakers discussing different clinical cases which, he felt sure, would provoke plenty of discussion.

ANNUAL GENERAL MEETING, December 14

THE ANNUAL GENERAL MEETING of the Society was held at Manson House, 26, Portland Place, London, W.1, on Monday, December 14, 1959, at 7 p.m. The President was in the Chair.

Minutes.—The Minutes of the previous Annual General Meeting were read by the Secretary, confirmed, and signed as a correct record.

Election of Officers and Councillors.—The PRESIDENT declared that, the Council having received no further nominations, the following officers were elected for the ensuing year:—

President: Mr. D. P. Walther.

Immediate Past President: Professor G. E. M. Hallett.

President-Elect: Mr. S. G. McCallin.

Senior Vice-President: Mr. K. E. Pringle.

Vice-President: Mr. W. Russell Logan.

Councillors: Mr. J. R. E. Mills, Mr. D. I. Smith, Mr. H. L. Leech, Mr. D. T. Hartley, Mr. P. E. Burke.

Treasurer: Mr. J. S. Beresford.

Secretary: Mr. B. C. Leighton.

Curator: Miss L. M. Clinch.

Editor: Mr. W. J. Tulley.

Librarian: Mr. A. G. Taylor.

Report of the Secretary.—The SECRETARY (Mr. B. C. LEIGHTON) presented his report as follows:—

It is a year now since Mr. Leech handed over to me this rapidly growing baby, with some words of encouragement and a suggestion that it may have to graduate to a larger cot in the near future. May I take this opportunity of expressing my gratitude to Mr. Leech for the excellent state of health in which the infant arrived. I have to report that this infant has continued to gain weight during the year, though not quite at the previous rate. Twenty-five new members have been elected and 20 have been lost through resignation or death. The membership is expected to reach 488 by the end of the year.

During the past twelve months, seven meetings of the Society have been held, with an average attendance of 86. One of these was a two-day Country Meeting, for which facilities were made available by the University of Manchester in their Dental and Medical Schools. The seriousness of the meeting was offset by a formal dinner.

The report was adopted.

Report of the Treasurer.—The TREASURER (Mr. J. S. BERESFORD) then presented his report: I am happy to report the excess of income over expenditure in the year.

Mr. BUNKER said that they had had an excess of income over expenditure of £981, and, according to his arithmetic, that left the Society possessing £5800. What was to be done with that money? Was it to be spent on research, for instance? For every one of the last few years there had been an excess of income over expenditure and there was obviously no danger that the Society would incur a loss. They had to decide what was to be done with the money. There was no point in merely amassing it. It should be devoted to research or to permitting members' subscriptions to be lowered.

The TREASURER replied that the Society must have in hand sufficient money to pay for the Transactions, 1958–59, and for an unknown charge for extra printing in the *Dental Practitioner*. They had ploughed back £300 into the current account which had been held in reserve for many years because he had not known, and had not been able to find out, the full extent of their commitments to the publishers. There were two unknown factors to be taken into account. One was the cost of extra pages in the *Dental Practitioner* and the other was that if they fell short of 200 members subscribing to the *Dental Practitioner*, the publishers had to be paid accordingly. He had no sooner ploughed back the £300 to which he had referred than he received a bill for £100 for the short-fall over the last four years.

That did not altogether answer the question of what was to be done with the money. He did not know the answer—he wished that he did. All the suggestions which had been made in Council would dispense with all their funds in a very short time. One suggestion had been the publication of their own journal of orthodontics. That would demand the services of a full-time, or nearly full-time, person, probably a dental surgeon commanding a competitive salary.

Rightly or wrongly, he intended to continue to build up rescrves, even though he did not know what to do with them. He was sure that in due course someone would be able to make an appropriate suggestion. When he first became a member of the Council, the Society was in debt and getting more and more into debt. Mr. Chapman had pulled them out of debt just before bcing succeeded by himself, and he kept the memory of that debt in his mind. If anyone wanted to undertake research or printing of the Society's own journal, more money than the Society had would be needed.

Mr. BUNKER said that he was quite happy with that answer so long as the Council realized that the Society was amassing a considerable sum and so long as the Council were prepared to keep an eye on the balance and ensure that it did something useful. If it were to be devoted to research, it might be an idea if members were informed of what sort of eapital would bc required and how long it would take to gct it.

The PRESIDENT said that the Council had discussed the matter several times. They had been very anxious to have their own journal but they had found that it would take about £3000 of backing before they could embark on that project and they had decided that that was too big a burden, attractive though the idea had at first seemed. Aftcr paying for the *Transactions* and having something to carry forward, there was not very much left. The sum itself was not large.

The Report and Accounts were adopted.

Report of the Curator.—The CURATOR (Miss L. M. CLINCH) presented her report as follows:

The Museum is still housed next door to Manson House in the Institute of Public Health, 28, Portland Place, where it can be seen on weekdays between 10 a.m. and 5 p.m.

During the year the following additions were made:—

1. Acrylic models with a clear inset and X-rays illustrating a case of inverted lower mesiodens associated with an unerupted lateral incisor, presented by Mr. G. B. Hopkin.

2. Models, X-rays, and photographs of dizygotic twins with an ectodermal dysplasia, presented by Mr. J. Gardiner.

3. Models and photographs of the X-rays of a case of complete anodontia of the permanent dentition with a complete deciduous dentition, presented by Mr. J. N. Swallow.

4. Serial models of young children.

Photographs of Dr. Northcroft and Mr. Rix were borrowed by Mr. H. E. Wilson for inclusion in a demonstration by the London Hospital at the Centenary Celebrations of the Royal College of Surgeons.

The PRESIDENT said that younger members of the Society might not have yet visited the museum. Much hard work went into the cataloguing of items and it seemed a shame to have a museum and collection of materials which was so rarely inspected or used. The museum was not far from the Society's headquarters and he assured younger members—and those older members who had not yet taken advantage of the museum's facilities—that a visit was well worth while.

Mr. WILSON said that he would like to take the opportunity to thank the Curator and the Society for the loan of the material which had been used for the Centenary Celebrations of the Royal College of Surgeons.

The Curator's Report was adopted.

Report of the Editor.—The EDITOR (Mr. W. J. TULLEY) presented his report as follows:

I have to report that the *Transactions* for 1958 are not yet available but will be shortly. We had hoped they would be available much earlier in view of the fact that we were printing directly from the articles published in the *Dental Practitioner*. However, there have been three major problems:—

1. Much of the material did not arrive promptly from the authors.

2. The printing strike which left the publishers with a big build-up of work to be done.

3. Delays in the binding.

I am doing my best to hasten the matter.

The printing strike has also held up this year's articles but I am pleased to say that authors have been most co-operative in producing their material. Once again, may I stress how important it is to receive short practical communications from members. It is the Society's policy to have a communication where possible before a main paper, particularly if that paper is of a theoretical nature, and I will once again ask all those in charge of departments and those who have access to a large amount of clinical material in their practices to come forward with interesting case reports. I hope that the younger men will not be intimidated by fear of criticism from their elders who may equally well be criticized for their prejudices. The Council have considered whether it would be possible to accept for publication case reports and short papers which have not been read before the Society. This would mean altering the name of the *Transactions* and, therefore, after considerable thought, they have rejected this proposal, but it will be reviewed again in two years if large numbers of papers become available.

There is every reason to hope that the *Transactions* for this year should appear quite quickly but I hesitate to make promises in the light of our recent experience.

I beg to move the acceptance of this report.

Asked what proportion of printing costs went in binding, the EDITOR said that that was a question which he could not answer without written notice.

The Editor's Report was adopted.

Report of the Librarian.—The LIBRARIAN (Mr. A. G. TAYLOR) presented his report, as follows:—

There have been a number of additions to the Library:—

The thanks of the Society are due to Mr. D. F. Glass for *a gift of reprints.*

The following books have been purchased:

Dickson, *Orthodontics in General Practice.*

Morrees, *The Dentition of the Growing Child.*

The Library has had a busy year with twice the turnover achieved in 1958, and only just short of the record year, 1957.

By purchase or exchange the Library received, among others, the following journals:—

The Angle Orthodontist; The American Journal of Orthodontics; The Dental Practitioner; the *Journals* and *Transactions* of: The Roumanian Dental Society; The French Orthodontic Society; The Spanish Orthodontic Society; etc.

Finally, the *Transactions* of the Society are sold all over the world.

The Librarian's Report was adopted.

The following candidates were duly elected:

Mrs. J. A. Franklin, L.D.S., 218, Pinner Road, Harrow, Middlesex;

Mr. G. F. Kennedy, B.D.S., 66, Fitzwilliam Square, Dublin, Eire;

Mr. J. S. Spencer, L.D.S., 65, Mt. Ephraim, Tunbridge Wells, Kent;

Mr. T. G. N. Williams, B.D.S., 13, Mayfield Road, Albrighton, near Wolverhampton.

The Society's Auditors were re-elected.

The PRESIDENT said that there was not to be a Country Meeting in the coming year, partly because the European Orthodontics Society were meeting in Belfast from June 30 to July 5. He hoped that members would note those dates and that those thinking of becoming members would do so, in order that they could attend that meeting so that British orthodontists would be well represented and able to meet their colleagues from all over Europe and from most of the northern hemisphere.

He said that he was very pleased to welcome guests and visitors. He asked them to consider themselves members of the Society for the evening and to take part in any discussions which might follow the communications.

As would be seen from the programme, three communications instead of one main paper were to be presented. They had always wanted to have an evening of that nature and he hoped that they would be able to continue to have something of that kind in future so that they could discuss cases which had been treated. Indeed, he hoped that such evenings would become a regular feature of the Society's meetings.

The first contributor was Mr. P. H. Burke, consultant orthodontist at Newcastle Dental Hospital, who was to present a communication.

Mr. Burke then gave his communication entitled:—

"*Contrasting Treatment in Two Brothers*"

The second contributor was Mr. J. R. Halden, who presented a communication entitled:—

"*Further Report on a Case Demonstrating Bodily Movement of Upper Incisor Teeth*"

Mr. W. J. Tulley then prescnted the third and final communication entitled:—

"*Cinéradiographic Studies of Tongue Behaviour*"

PRESIDENT'S VALEDICTORY ADDRESS

Professor Hallett said that he had come to the end of his year of office. There was a time, only a few years before, when, he could truthfully say, it never crossed his mind that in the near future he would be honoured with the Presidency of the Society. He had often felt a little guilty in occupying the Chair without a general air of venerability, which he had come to associate with such a position. He might have been deceiving himself over that because venerability may have come over him without his noticing it in his shaving mirror.

It had been a very happy and most interesting year for him. He could look back on the Country Meeting at Manchester and to the wonderful co-operation which they had received there. The success of that meeting had been very largely due to the officials of the Society, and particularly to Mr. Hartley who had worked so very hard for it.

He could also look back to the Centenary Celebrations of the Royal College of Surgeons, which he had attended as the Society's representative. On behalf of the Society, he had presented the College with an illuminated address.

Over the year they had had very good attendances and enthusiastic support. That was partly a reflection of the widespread recognition which orthodontics now enjoyed as a fundamental specialty of dental surgery. It was also largely due to the very hard work which the Society's officials put in and for which he could claim practically no responsibility.

There was first the Secretary, Mr. Leighton, who had come newly to the task after Mr. Leech. Mr. Leighton had worked hard and had carried on the efficient organization which Mr. Leech had left behind. They were most grateful to Mr. Leighton for his efforts.

Mr. Beresford, the Treasurer, had devoted much care and meticulous attention to managing the Society's finances and accounts and the steady amassing of reserves. He sometimes thought, with Shakespeare, that Mr. Beresford might take for his motto, "I did dream of money-bags to-night".

There was no surer way of running a society into trouble than having a poor secretary and treasurer. There was not the slightest risk of this and they were fortunate in having the members they had in these offices.

He appreciated also the enormous amount of work which was done by Mr. Tulley, the Editor. The Society had every cause to be very grateful for all that went into the production of the *Transactions* and they were very fortunate in having Mr. Tulley to undertake that task.

He had to thank Mr. Leighton personally for keeping the Minutes and for permitting the President occasionally to "pinch" the Secretary's pieces, although they were clearly marked in red!

He had to thank the Council for regular attendance and constant vigilance over the affairs of the Society.

He was now about to hand over to Mr. Walther, an old friend—or should he say, a friend of long standing. (Laughter.)

He did not know of anyone who was more fitting to take over the Presidency. He had known Mr. Walther over about ten years, during which timc he had been in close contact with him on orthodontic matters—not only in the B.S.S.O., but in the European Orthodontic Society. Together they had travelled to Paris, Amsterdam, and Southern France on the affairs of orthodontic societies. They had had a few hours off duty with their Continental colleagues.

The PRESIDENT said that younger members, especially, might be interested in the coloured slides of the Presidential medallion which was now shown on the screen. He believed the figure shown to be Pierre Fauchard.

He then installed Mr. D. P. WALTHER with the Badge of Office.

The new PRESIDENT (Mr. WALTHER) thanked the Society for the very great honour bestowed on him. He was deeply conscious of the responsibility which had fallen on his shoulders. He would do his utmost to uphold the dignity and prestige of his high office and try to justify the trust which had been placed in him.

As they all knew, they had just concluded a most successful year under the able guidance of Professor Hallett. He hoped that when his turn came to account for his stewardship, he would be in a similarly favourable position.

He called upon Mr. Leech to propose a vote of thanks to Professor Hallett.

Proposing a vote of thanks, Mr. H. L. LEECH said that the first time he met Professor Hallett was at one of the first meetings which he attended, when Professor Hallett was the lecturer. As a somewhat precocious first-year registrar, he had not entirely agreed with what Professor Hallett said, probably because Professor Hallett was talking about the number of patients which an orthodontist should see in one year. Since then, Professor Hallett had become an examiner for the Diploma in Orthodontics, and he had learned to agree with him much more. (Laughter.)

Nevertheless, he remembered being very impressed by the masterly way in which Professor Hallett had presented his lecture. Since then, he had come to know him very much better and had been constantly impressed by his ability, whether putting over a lecture or addressing the Society and acting as President. He had always felt a little jealous of Professor Hallett's masterly knowledge of English and French which had stood him in good stead as Editor of the European Orthodontic Society.

He was sure that he spoke on behalf of all members of the Society when he said how grateful they all were to Professor Hallett for the hard work he had devoted to the Society in the past year. Much of the success of the Country Meeting at Manchester was due to his work and it was not to be forgotten that he had to come each time from Newcastle. He asked members to show their appreciation in the usual way.

The vote of thanks was received with acclamation.

Professor HALLETT expressed his thanks for the vote. He said he had enjoyed his year of office and had learned a great deal. Among other things, he had found a permanent niche in British Railways sleepers which he would try to fill for some years to come.

THE BRITISH SOCIETY FOR THE STUDY OF ORTHODONTICS

Balance Sheet and

Income and Expenditure Account

FOR THE YEAR ENDED SEPTEMBER 30, 1959

FREDK. B. SMART & COMPANY, CHARTERED ACCOUNTANTS

22 Queen Street, London E.C.4

The British Society for the Study of Orthodontics

INCOME AND EXPENDITURE ACCOUNT for the year ended 30th September, 1959

1958												
£	s.	d.			£	s.	d.	£	s.	d.		
10	10	0	To Museum Rent	.. .. ..				12	5	0		
110	14	5	,, Printing and Stationery	.. ..	101	4	0					
647	1	2	,, Cost of *Transactions* 1957	..	405	15	10					
43	15	0	,, *Practitioner*, Cost of Extra Printing		55	0	0					
								561	19	10		
56	6	5	,, Postage	.. ..				52	4	7		
5	0	0	,, Lantern and Film Expenses	..				6	0	0		
46	13	0	,, Hire of Hall	.. .. ..				33	3	0		
84	12	0	,, Reporting	.. ..				47	14	8		
126	17	2	,, Refreshments	.. .. ..				65	6	8		
57	7	2	,, Country Meeting	.. .. ..				73	9	10		
12	12	0	,, Audit and Accountancy	.. ..				38	17	0		
4	3	6	,, Insurance	.. ..				4	3	6		
7	17	6	,, Library and Journals	.. ..				2	17	6		
26	5	0	,, Northcroft Memorial Lecture	..				60	5	0		
23	2	0	,, Honoraria	.. ..				17	17	0		
11	2	4	,, Sundry Expenses	.. .. ..				28	9	6		
			,, Depreciation on Furniture and									
34	4	0	Equipment	.. .. ..				34	4	0		
			,, *Excess of Income over Expenditure*									
312	1	10	*for the year*	.. .. ..				981	5	11		
£1,620	4	6						£2,020	3	0		

1958												
£	s.	d.			£	s.	d.	£	s.	d.		
			By *Members' Subscriptions:*—									
			1959 Subscriptions	.. ..	1,395	3	5					
			Adjustment in respect of Past									
1,372	8	11	Years	.. ..	12	12	0					
								1,407	15	5		
122	14	5	,, Sales of *Transactions*	.. ..				144	10	2		
			,, *Interest Received:*—									
15	0	0	Savings Certificates	.. ..	12	10	0					
17	5	4	2½% Consolidated Stock	..	17	5	4					
20	0	0	4% Consolidated Stock	..	20	0	0					
17	10	0	3½% Defence Bonds	.. ..	17	10	0					
			5¼% Hertfordshire County									
18	2	4	Council Stock (net)	.. ..	18	14	1					
			5¼% Corporation of London									
15	2	0	Stock (net)	.. .. ..	15	11	10					
22	1	6	Post Office Savings Bank Account		22	12	6					
								124	3	9		
			,, *Income Tax recoverable to 5th*									
			April, 1959	.. .. ..				43	13	8		
			,, *Printing Reserves Written Back*	..				300	0	0		
£1,620	4	6						£2,020	3	0		

The British Society for the Study of Orthodontics

BALANCE SHEET as at 30th September, 1959

1958								
£	s.	d.		£	s.	d.	£	s. d.
			Accumulated Fund:—					
			Balance at 1st October, 1958 ..	3,660	6	10		
			Add Excess of Income over Expenditure for the year	981	5	11		
3,660	6	10					4,641	12 9
			Creditors:—					
			Transactions 1958 and 1959 (estimated by the Hon. Treasurer) ..	1,050	0	0		
1,200	0	0						
			Dental Practitioner Short Fall Account	–	–	–		
150	0	0						
			Dental Practitioner Extra Cost of Printing	75	0	0		
20	0	0						
26	5	0	Northcroft Memorial Lecture ..	26	5	0		
27	0	0	Hire of Hall	13	10	0		
7	17	6	Museum Rent	9	12	6		
12	17	6	Subscriptions in Advance ..	5	0	0		
			Sundry Expenses	12	4	6		
			Audit and Accountancy	26	5	0		
							1,217	17 0
£5,104	6	10					£5,859	9 9

S. B. NEWTON, T. L. WINN } *Hon. Auditors*
J. S. BERESFORD, *Hon. Treasurer*

1958								
£	s.	d.		£	s.	d.	£	s. d.
			Furniture and Equipment:—					
			Balance at 1st October, 1958 ..	302	13	0		
302	13	0	*Less* Depreciation at 5% per annum	34	4	0		
							268	9 0
			Investments:—					
			600 National Savings Certificates,					
465	0	0	at cost plus accrued Interest ..	477	10	0		
			£691 5s. 10d. 2½% Consolidated					
575	14	0	Stock at Cost	575	14	0		
			£500 0s. 0d. 4% Consolidated					
485	6	3	Stock at Cost	485	6	3		
			£500 0s. 0d. 3½% Defence Bonds					
500	0	0	at Cost	500	0	0		
			£600 0s. 0d. 5¼% Hertfordshire					
597	9	6	County Council Stock at Cost	597	9	6		
			£500 0s. 0d. 5¼% Corporation of					
508	10	9	London Stock at Cost	508	10	9		
			(Approximate Market Value £2,792)				3,144	10 6
			Income Tax Recoverable				43	13 8
			Cash at Bank:—					
759	3	2	Westminster Bank Limited ..	971	12	0		
905	14	3	Post Office Savings Bank ..	1,428	6	9		
							2,399	18 9
			Cash in Hand:—					
1	17	6	Honorary Treasurer	4	15	8		
2	18	5	Honorary Secretary (overspent) ..	1	17	10		
							2	17 10
£5,104	6	10					£5,859	9 9

Certified in accordance with the Books and Vouchers of the Society.
We have verified the Investments and Cash at Bank.
FREDK. B. SMART & CO.,
Chartered Accountants,
22, Queen Street, London, E.C.4.

28*th October*, 1959.

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